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**RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
FACILITY AND NEW JERSEY REMEDIAL INVESTIGATION REPORT**

**GENERAL MOTORS CORPORATION
GENERAL MOTORS VEHICLE MANUFACTURING - LINDEN
ASSEMBLY PLANT**

**1016 WEST EDGAR ROAD
LINDEN, NEW JERSEY**

**US EPA ID # NJD002186690
~~NJDEP Case No. 95-01-25-1618-35~~**

VOLUME 1 - TEXT

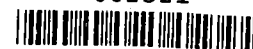
Prepared for
ENCORE, INC
Detroit, Michigan

by

ENCORE, LLC
Newark, New Jersey

September 29, 2004
File No. 28499-112

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
AOI	Area of Interest
AMF	Anchor Motor Freight, Inc.
AST	Above Ground Storage Tank
BEE	Baseline Ecological Evaluation
Bell	Bell Environmental
Bgs	Below Ground Surface
BN + 15	Base/Neutral Extractable Compounds (Priority Pollutants List) With a Forward Library Search for 15 Tentatively Identified Compounds
CA	Corrective Actions
CCR	Current Conditions Report
CRA	Conestoga-Rovers & Associates
CRTK	Community Right to Know
CVOCs	Chlorinated Volatile Organic Compounds
DICAR	Discharge Investigation and Corrective Action Report
°F	Degrees Fahrenheit
EPI/PA	Environmental Priorities Initiative/Preliminary Assessment
Facility	General Motors Vehicle Manufacturing Linden Assembly Plant
FSP	Field Sampling Plan
FW	Fresh Water
GM	General Motors
gpd	gallons per day
GWQS	Ground Water Quality Standards
HQ	Hazard Quotient
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
KCSL	Known Contaminated Site List
LRSA	Linden-Roselle Sewer Authority
LNAPL	Light Non-Aqueous Phase Liquid
MCL	Maximum Contaminant Level
MOA	Memorandum of Agreement
MSDS	Material Safety Data Sheet
MTBE	Methyl Tert-Butyl Ether
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJPAR	New Jersey Preliminary Assessment Report
NRCS	Natural Resource Conservation Service
NT	Non Trout
OH	Olsen and Hassold
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyls
PE	Post-excavation
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PN	Plant North

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PRG	Preliminary Remediation Goals
PQL	Practical Quantitation Limit
QAPP	Quality Assurance Project Plan
RAW	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RIR	Remedial Investigation Report
RQD	Rock Quality Designation
SE	Saline Estuary
STL	Severn Trent Laboratories
SVOC + 20	TCL Semi-Volatile Organic Compounds + 20 TICs With a Forward Library Search for 20 Tentatively Identified Compounds
SWMU	Solid Waste Management Units
TAL	Target Analyte List
TBA	Tert-Butyl Alcohol
TCL	Target Compound List
TIC	Tentatively Identified Compounds
TLV	Threshold Limit Value
TN	True North
TP	Trout Production
TPH	Total Petroleum Hydrocarbons
TSDf	Treatment, Storage, Disposal Facility
USDA	United States Department of Agriculture
UL	Urban Land
US	United States
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs + 10	Target Compound List Volatile Organic Compounds + 10 TICs With a Forward Library Search for 20 Tentatively Identified Compounds
WWTP	Wastewater Treatment Plant

I. INTRODUCTION

1.01 Purpose

This Resource Conservation and Recovery Act (RCRA) Facility Investigation and New Jersey Remedial Investigation (RFI/RI) Report was prepared under the direction of Environmental Corporate Remediation Company (ENCORE), a wholly owned subsidiary of General Motors Corporation (GM), for the General Motors Vehicle Manufacturing Linden Assembly Plant (the "Facility"). The Assembly Plant is located at 1016 West Edgar Road, Linden, New Jersey (Figures 1 and 2). This report was prepared to fulfill one of the requirements of the Memorandum of Agreement between GM and the New Jersey Department of Environmental Protection (NJDEP) dated February 27, 1995. The New Jersey Case No. is 95-01-25-1618-35. This document includes the two-part certification required by New Jersey Administrative Code (NJAC) 7:26E -1.5. (Appendix A). This report was also prepared in conjunction with a voluntary RCRA corrective action that GM is conducting at the Facility. The United States Environmental Protection Agency (USEPA) ID Number for this Facility is #NJD002186690

The Linden Assembly Plant is a RCRA-regulated generator. The Facility submitted a Part A - RCRA permit on November 17, 1980. Rather than pursue a full operating permit, the Facility opted to stop functioning as a treatment, storage and disposal facility (TSDF) and changed its RCRA status from a TSDF to a generator. As such, the Facility submitted a closure plan in May 1989 for one indoor hazardous waste storage tank (SWMU 6 located in AOI 6) and two former outdoor hazardous waste container storage areas (AOIs 1 and 15). The Facility then closed its TSD units and changed its RCRA status to a generator.

The Current Conditions Report and Preliminary Assessment Report (CCR/PAR) (ENCORE, LLC, 2002) submitted to the USEPA and NJDEP (May 2, 2002) contains facility background information, facility setting, discharge history, and investigation history. The CCR/PAR also summarizes 24 individual areas at the Facility that may have had a release to the environment. These areas were identified during a file review, interview process, previous investigations, and Facility visits. These areas have been designated as Areas of Interest (AOI). Areas of Interest include Hazardous Waste Management Units (HWMU), Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs) identified in the RCRA Facility Assessment (RFA) (USEPA, 1993) and Preliminary Assessment/Visual Site Inspection (PA/VSI), and additional areas identified during the development of the CCR and implementation of the RFI. Based on information gathered during development of the CCR/PAR, certain AOIs were determined not to require further investigation due to the absence of evidence of a release to the environment or because of previous work conducted. The basis for eliminating these AOIs from further investigation is documented in the CCR/PAR.

Five additional AOIs (AOI 25 through AOI 29) have been identified during implementation of the RFI. These AOIs are:

- AOI 25 Former Drum Storage Area
- AOI 26 Suspected Abandoned UST
- AOI 27 Stained Asphalt Area
- AOI 28 Southern ^[PN] Facility Boundary Area
- AOI 29 Monitoring Well 18 Area

For AOIs that warranted further investigation based on the documentation in the CCR/PAR, ENCORE prepared a RFI/New Jersey Remedial Investigation Work Plan (Work Plan) to determine whether the AOIs had released hazardous waste or hazardous constituents that pose an unacceptable risk to human health or the environment. The RFI/RI was conducted in accordance with the RFI/RI Work Plan (Haley & Aldrich, 2002) and supplemental work plans for additional phases of field investigations presented at working meetings between GM and the agencies.

This RFI/RI Report describes the procedures, methods, and results of the field investigations conducted during the RFI/RI. The information includes the results of comparisons of the RFI/RI data with screening criteria during the RFI/RI field investigation to identify whether there is a potentially significant release of hazardous waste or hazardous constituents at each AOI (or group of AOIs where they were grouped for investigation), and to guide characterization of any potentially significant release. Where a potentially significant release was identified, characterization of the nature and extent of the release for risk evaluation purposes is also discussed. The significance of releases identified during the RFI/RI is evaluated in a human health risk assessment included in this Report to identify AOIs where corrective measures are warranted.

The work was conducted under the direction of ENCORE by the following main firms:

- Haley & Aldrich conducted the field investigation activities, and data validation;
- ENVIRON conducted the human health risk assessment;
- Severn Trent Laboratories (STL) conducted the laboratory analyses; and
- Conestoga-Rovers & associates (CRA) provided data management and figure preparation.

1.02 Report Organization

The RFI/RI Report is organized as follows:

- Section 1 provides an introduction to the Facility, work activities, primary firms involved in the project, and report organization.

- Section 2 provides an overview of the RFI/RI, including a summary of the AOIs investigated during the RFI/RI, a summary of the stages of RFI/RI field investigations and the general approach to the RFI/RI.
- Section 3 discusses the environmental setting in the vicinity of the Facility, including information on surface water hydrology, geology, hydrogeology, background soil characteristics, land use, groundwater use, and local ecology.
- Section 4 presents a summary and discussion of the RFI/RI results for each of the AOIs investigated. The discussion for each area investigated includes a summary of the scope of the field investigations, a summary and evaluation of the RFI/RI data with respect to whether a potentially significant release of hazardous constituents has been identified and the nature and extent of any releases for risk evaluation purposes.
- Section 5 presents a baseline risk assessment that evaluates the significance of hazardous constituents in affected environmental media at the investigated areas to determine whether corrective measures are warranted. The risk assessment identifies scenarios for potential exposure under current and reasonably expected future land use at and around the Facility. Estimates of cumulative cancer and noncancer risks associated with reasonable maximum exposures under these scenarios are compared to USEPA-established limits to identify conditions that warrant corrective measures.
- Section 6 summarizes the conclusions of the RFI/RI.
- Section 7 lists the references cited in the report.
- Tables and Figures cited in the text of the report are found in Volume 2 of this report. Appendices cited are found in Volume 3 of the report.
- Appendix A presents the New Jersey certification required by NJAC 7:26E and a cross reference table providing a key to the locations in this RFI/RI Report of the items required by the New Jersey RI Report.
- Appendix B contains the Facility soil boring logs and monitoring well construction logs for all the soil borings installed during the RFI/RI and groundwater monitoring wells sampled during the RFI.
- Appendix C contains a summary of the hydrogeologic testing results, including packer permeability testing, rising head permeability testing, and water level measurements conducted during the RFI.

- Appendix D contains the Facility specific compound lists for TCL VOCs, TCL SVOCs, TAL metals (inorganics), and PCBs, as well as laboratory analytical methods.
- Appendix E contains laboratory analytical data summary tables that summarize all the RFI/RI soil, groundwater, borehole water, sediment, and surface water data.
- Appendix F contains laboratory analytical data in the form of a compact disk (CD) with the complete analytical data, which includes laboratory reports in .pdf format and New Jersey Electronic Disk Deliverable format.
- Appendix G contains a summary of the RFI/RI data validation process.
- Appendix H contains an evaluation of tentatively identified compounds.
- Appendix I contains Merck & Safety Kleen Groundwater Contour Maps.
- Appendix J contains downhole borehole geophysical information.
- Appendix K contains water supply information from the Elizabethtown Water Company (a private water company which provides potable water in Linden, New Jersey) and water well information from the NJDEP.
- Appendix L contains the Baseline Ecological Evaluation.
- Appendix M contains additional information and calculations that support the human health risk assessment.

II. OVERVIEW OF THE RFI

2.01 Facility Description

The Facility location is depicted on Figure 1. True north (TN) is north as presented on the United States Geological Survey maps depicting the Facility and its surrounds. Plant north (PN) is the direction historically used by the Facility to depict "north" at the Facility with respect to the building layout, which varies by approximately 56 degrees. All directions referenced in this report refer to plant north and are followed by (PN), unless noted by (TN).

The Facility is located on approximately 94 acres of land in an area of mixed industrial/manufacturing and commercial facilities with small areas of residential development to the north^(PN), east^(PN), and south^(PN) of the Facility, as shown on Figure 2. It is located along Routes 1 and 9 in Linden, Union County, New Jersey. The plant consists of one large assembly building, the administration building, several significantly smaller buildings, and the wastewater treatment plant (WWTP). The main assembly building occupies approximately 37.5 acres. Current and historic waste management facilities are located in and around the exterior of the main manufacturing building.

The Facility is utilized for vehicle assembly operations and currently manufactures small trucks and sport utilities such as the Chevrolet Blazer and S-10 Crew Cab Pickup. Automobile components are primarily assembled at other plants and are shipped to Linden via trucks and railway for the assembly process. The Facility assembles the body and chassis with the major components, applies primer, paint and clearcoat via robotic spray application and body rust protection/primer via electrodeposition process (ELPO), installs the interior and exterior trim, adds necessary auto fluid, and completes a final vehicle inspection and any needed repair prior to shipment of the vehicle. Additional details are provided in the CCR/PAR (ENCORE, 2002).

2.02 Field Investigations

A. Areas Investigated

The CCR/PAR identified 14 AOIs where further investigation was warranted based on evidence of a past release, historic operations, visual observations, file review results, or previous sampling results. Five additional areas: AOI 25 - Former Drum Storage Area, AOI 26 - Suspected Abandoned UST, AOI 27 - Stained Asphalt Area, AOI 28 - Southern^(PN) Facility Boundary Area, and AOI 29 - Monitoring Well 18 Area, were identified during the RFI/RI, which warranted further investigation.

Table 2.02.1 summarizes the AOIs requiring further investigation, the potentially impacted media, and analytical suites intended to characterize the chemical quality of impacted media, if any, at these AOIs. The AOIs which warranted further investigation are shown on Figure 3.

B. Preliminary Groundwater Investigation

A preliminary groundwater investigation of soil and groundwater along the perimeter of the Facility was conducted during July and August 2002, prior to the implementation of the RFI/RI. This investigation included installation of four clusters of three wells, groundwater samples from these wells, and soil samples from each cluster. The clusters are located near the mid-point of each of the four outer property lines. Each cluster consists of one well across the water table, one well in the weathered bedrock, and one in the bedrock. Field methods and procedures, and field activities for the preliminary investigation are the same as for the RFI/RI investigation discussed below in the following section.

C. RFI/RI Field Investigation

The RFI/RI field investigation was initiated in July 2002. Based on preliminary laboratory results obtained during the initial RFI/RI field investigation, additional field investigations were implemented. The additional field investigations were necessary to supplement the original RFI/RI Work Plan. The scope of work for these additional investigations were presented to the USEPA and NJDEP during working meetings. Investigation results and updated field activities were also presented during these meetings.

Field investigations for the 20 AOIs identified in the RFI/RI Work Plan and Addenda were substantially completed in March 2004.

1. Field Methods and Procedures:

The methods and procedures used in the field investigations for the RFI/RI were conducted in accordance with the RFI/RI Work Plan, which includes the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). Any deviations from the RFI Work Plans are noted below and in Section IV. Samples were typically collected from the surface interval (0 to 2-feet) and immediately above the water table (typically 8 to 10-feet). An intermediate interval was also sampled if field conditions suggested possible contamination. Samples were submitted for an AOI-specific list of analytes and included analysis for TCL VOCs, TCL SVOCs, TAL metals, PCBs, and cyanide.

Complete compound lists for TCL VOCs, TCL SVOCs, TAL metals, PCBs, and/or cyanide are provided in the RFI/RI Work Plan and in Appendix D. A summary of the investigation activities and analytical list for each AOI is provided in Table 1.1. The results of the investigation are summarized and discussed in Section IV.

2. Field Activities:

Field activities for the RFI/RI were conducted in three Field Events (Preliminary Groundwater Evaluation, Stage I and Stage II). In general, each field event included soil sampling and analysis, monitoring well installation, water level measurements, groundwater sampling and analysis and hydrogeologic measurements. Field activities for each AOI location are detailed in Section IV, boring logs and well completion reports are contained in Appendix B, and hydrogeologic testing results are summarized in Appendix C. Field activities were conducted in accordance with the RFI/RI Work Plan, which includes the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). The data collected during field events were evaluated using screening criteria and professional judgment to identify environmental conditions that warranted further investigation. The results of these reviews provided the basis for developing plans for additional field activities (i.e., Stage I and Stage II).

The Preliminary Groundwater Investigation was conducted from July 2002 to August 2002 and consisted of the following work activities:

- Installation of four well clusters; the clusters are located at the approximate midpoint of each of the four property lines. Each cluster contains a well across the water table (S well), one in the weathered bedrock (W well) and one in the bedrock (B well).
- Collection and analysis of soil samples from one boring in each cluster location for subsequent chemical analysis (4 cluster locations, 11 soil samples)
- Collection and analysis of groundwater samples from the 12 new wells and 6 previously existing wells for subsequent chemical analysis (18 groundwater samples).
- Installation of a profile boring adjacent to existing well BEC-2D to profile the stratigraphy (3 soil samples).

Stage I was conducted from January 2003 to May 2003 and consisted of the following work activities:

- Installation of 4 monitoring wells and 34 Geoprobe borings.
- Collection and analysis of 67 soil samples.
- Collection and analysis of 40 groundwater samples from new and existing wells.
- Collection and analysis of two borehole water samples.
- Collection and analysis of 3 composite sediment samples from active storm sewer catch basins.
- Packer testing and downhole geophysics on existing bedrock wells.
- Slug testing of all new monitoring wells installed.
- Water level measurements in August and September 2002 and January 2003.
- Collection and analysis of groundwater samples from selected monitoring wells on January 22 through February 5, 2003, May 20, 2003, and April 16, 2003.

Stage II was conducted from June 2003 to May 2004 and included the following activities:

- Installation of 26 monitoring wells, 126 Geoprobe borings and 4 hand auger borings.
- Collection and analysis of 326 soil samples.
- Collection and analysis of 59 groundwater samples.
- Collection and analysis of 4 stormwater samples and 5 sediment samples.
- Collection and analysis for waste characterization on a sample of contaminated soil.
- Collection and analysis of a water sample from a building sump.
- Slug testing of all new unconsolidated wells.
- Packer testing of the new bedrock well.
- Water levels were measured in June, August, October and December 2003, and March 2004.
- Collection and analysis of groundwater samples from selected monitoring wells during the period of October through December 2003.
- Completion of a Baseline Ecological Evaluation (BEE) per N.J.A.C. 7:26E.

3. Laboratory Procedures

The analytical suites for all samples submitted to the laboratory were specific to each AOI and are identified in Table 1.1. All methods and procedures for the analyses were performed in accordance with the RFI/RI Work Plan QAPP. The analytical suites, laboratory methods, constituents and Practical Quantitation Limits (PQLs) that were used by the laboratory are summarized in Appendix D. The laboratory analytical data are summarized in Appendix E, while the full laboratory analytical data is provided on a compact disk in Appendix F.

The laboratory analytical data was validated in accordance with the RFI/RI Work Plan QAPP. The results of the validation are summarized in Appendix G.

a). Tentatively Identified Compounds

In accordance with the RFI/RI Work Plan, samples collected during the Preliminary Groundwater Investigation and Stage I of the investigation were analyzed with a library search identification of tentatively identified compounds (TICs) in the organic fractions (VOCs and, SVOCs). The TICs are a requirement of the NJDEP Technical Requirements (NJAC 7:265).

Upon review of the analytical data containing TICs, GM identified that the TIC data did not create any area or levels of concern (based on risk) that the data from the targeted compounds had not already identified. Therefore, generation of additional TIC data would not materially contribute to further understanding of the Facility and should not be required in future RFI/RI activities. Consequently, GM requested and was verbally granted the elimination of TICs from future analytical requirements during the meeting with USEPA and NJDEP in July 2003,. Analysis of the TIC data and the basis for these conclusions is presented in Appendix H. Sample analyses during subsequent field stages have not included reporting of TICs.

D. RFI/RI Objectives and Approach

The approach of this RFI/RI was to characterize the nature and extent of releases of hazardous waste and/or hazardous constituents at or from the identified AOIs at the Facility. This RFI/RI Report also provides support for the Environmental Indicators (EI) determinations and any interim and final corrective measures that may be required.

The objective of the RFI/RI is to collect data of sufficient quality and quantity to support an assessment of potential current and future risks to human health and the environment associated with releases of hazardous waste and/or hazardous constituents. Specifically, the objectives of the RFI/RI are to:

- Determine Facility-wide hydrogeologic conditions, as necessary, to investigate releases from AOIs;
- Determine whether a potentially significant release of hazardous waste and/or hazardous constituents to soil, groundwater, surface water, or sediment has occurred at AOIs identified in the CCR/PAR as requiring investigation;
- Characterize the nature and extent of releases of hazardous waste and/or hazardous constituents in environmental media at the Facility;
- Characterize actual and potential migration pathways, potential human and environmental receptors, and current and reasonably expected future land and groundwater uses;
- Assess potential risk to human health and the environment associated with releases of hazardous waste and/or hazardous constituents;
- Provide sufficient data to support a demonstration that current human exposures are under control, and that the migration of contaminated groundwater is stabilized for the RCRA corrective action environmental indicators determination;
- Determine whether interim measures are necessary to control current human exposures, or to control migration of contaminated groundwater; and
- Determine whether a Corrective Measures Study (CMS) and New Jersey Remedial Action Work Plan are necessary to evaluate alternatives for addressing significant risks, if any, to human health and the environment.

The RFI/RI was conducted in a staged approach, with two stages of investigation (Stage I and II) completed to date. The initial RFI/RI Work Plan was prepared to describe the investigation activities intended to evaluate Facility conditions and to attain the RFI/RI objectives described above. After each stage, adequacy of the data was evaluated to determine whether additional data collection was warranted and a supplemental work scope was prepared. Additional field stages were necessary to collect supplemental soil, surface water, groundwater, and sediment information to achieve RFI/RI objectives, as discussed

above. When data of sufficient quality and quantity has been collected, it was used to support decisions regarding the need for interim or corrective measures as discussed above.

III. ENVIRONMENTAL SETTING

3.01 Location and Physiography

The Facility is located on approximately 94 acres of land in an area of mixed industrial/manufacturing and commercial facilities. Small areas of residential development lie to the north^(PN), east^(PN), and south^(PN) of the Facility. The Facility is located along Routes 1 and 9 in Linden, Union County, New Jersey, in the northwestern^(TN) and northeastern^(TN) portions of the 7.5 minute Perth Amboy, New Jersey and Arthur Kill, New York topographic quadrangles, respectively (Figure 1).

The plant currently consists of one large assembly building, an attached administration building, several significantly smaller buildings, and the wastewater treatment plant (WWTP). The main assembly building occupies approximately 37.5 acres. Current and historic waste management facilities are located around the exterior of the main manufacturing building.

The topography of the Facility is generally flat, with a slight slope to the southeast^(TN) towards the Rahway River and Arthur Kill. The area surrounding the Facility is generally developed, flat-lying and is located in an area of industrial and commercial properties. The Facility lies at approximately 25 feet above mean sea level.

3.02 Climate

The climate of Union County is humid and temperate with the coastal area somewhat influenced by the tempering effects of the ocean. Union County has no other major physiographic features that influence climate. The temperature ranges from approximately 10° F (winter) to approximately 95° F (summer) with rainfall rather evenly distributed throughout the year at an average of 47 to 54 inches/year. The average first and last frosts occur on or about September 25 and May 17, respectively.

3.03 Surface Water Hydrology

The predominant drainage systems in the vicinity of the Facility are the Rahway River and the Arthur Kill. The Rahway River discharges into the Arthur Kill approximately four miles to the southeast^(TN) of the Facility. Local drainage occurs in small creeks and brooks that drain into the Rahway River or directly into the Arthur Kill. The Rahway River is located approximately one mile to the south^(TN) of the Facility.

Two local drainage ways are present near the Facility; Kings Creek to the southwest^(TN) of the Facility and West Brook (aka Morses Creek) to the northeast^(TN) of the Facility. Kings Creek drains into the Rahway River. Morses Creek, which receives the storm water runoff from the Facility via storm sewers, discharges into two small man-made reservoirs on a refinery site to the northeast^(TN) of the Facility. According to the USGS 7.5-minute quadrangles, Morses Creek discharges directly into the Arthur Kill.

The nearest surface waters to the Facility are Kings Creek, located about 1/8-mile south-southwest^(PN), and Morses Creek, which is located about 1/4-mile northeast^(TN) of the facility. Stormwater run-off from the Facility discharges via storm sewer into Morses Creek. Nearby surface water bodies are depicted on Figure 4.

These drainages connect to the Atlantic Ocean through the Newark Bay. A connection does not exist between these drainages and the surface water bodies used by Elizabethtown Water as a potable supply.

3.04 Soils

The soils underlying the GM Linden Facility and the areas immediately surrounding the Facility are classified by the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) as Urban Land (UL). The soils associated with Urban Land are characteristic of areas that have been paved or built upon and typically consist of clay and unconsolidated materials to a depth of 60 inches. The soils of these areas have been reworked to such an extent that the original soil profile cannot be recognized. The surface is level to nearly level, and permeability is generally poor. Included in this mapping area are loamy and small areas of undisturbed soils composing approximately 10 percent of the total map unit. (United States Department of Agriculture Natural Resources Conservation Service, 1992).

The USDA NRCS information indicates that the surface soil at the Facility is UL soil, which is comprised of brown silts, red-brown clayey silts, and well-graded sands with silt and gravel. A sand, silt, clay to gravely clay layer with a thickness of up to 20 feet, is noted to underlie the surficial soils beneath the Facility.

3.05 Regional Geologic Setting

The City of Linden is located within the Newark Basin, which is one of a series of step-faulted half-graben basins which extend linearly from Newfoundland to South Carolina and Georgia. The Newark Basin, contained within the Piedmont Physiographic Province, is

dominated by Upper Triassic to Lower Jurassic non-marine sedimentary stream and lake deposits interbedded with quartz normative, olivine-poor tholeiitic basaltic lava flows and intruded by diabasic sills and dikes. The beds in the basins generally strike northeast^(TN) to southwest^(TN) and dip between 5 degrees and 15 degrees northwest^(TN).

The bedrock underlying the Facility is of the Triassic-aged Passaic Formation (formerly designated as the lower part of the Brunswick formation) which consists of a series of alternating beds of sandstone, siltstone, and shale interbedded with a conglomeratic faces along the basins faulted northeast border. The Passaic Formation is the thickest and most widespread formation in the Basin section with thicknesses averaging 2,700 meters and measuring upwards of 3,500 meters in the Jacksonwald syncline (Olsen, 1996).

Upward vertical trends within the Passaic Formation indicate a decrease followed by an increase in grain size of the sediments making up the formation. Also, an upward change from a massive mudstone to a mudstone interbedded with siltstone and sandstone bands has been observed in cores obtained from the formation. Sediments of the Newark Basin were subsequently overlain by a mantle of Jurassic to Holocene consolidated and unconsolidated sands, gravels, silts, and clays.

This basin contains early Mesozoic of Late Triassic to Early Jurassic age and is a northeast trending half graben bounded on the northwest by normal faults. The basin is filled with a thick sequence of fluvial and lacustrine rocks and lava flows, the composite sequence is approximately 24,600 feet thick. Triassic sedimentary rocks unconformably overlie crystalline rocks of the Manhattan prong along the eastern margin of the basin. The Newark basin is unconformably overlain by Cretaceous sediments of the Coastal Plain in the southeastern part of the map area (USGS, 1996 Miscellaneous Investigation Series Map I - 2540-A).

3.06 Geology and Hydrogeology at the Facility

A. Overburden

The overburden at the Facility consists of fill, glacial till, and weathered siltstone.

1. Overburden Conditions Identified During RFI/RI Activities: Approximately 190 subsurface explorations have been completed at the Facility for the RFI/RI. The borings indicated a generally consistent stratigraphic profile in the overburden across the Facility, however the stratigraphic depths and unit thicknesses varied. Figure 5 shows the locations of the cross sections on the base map and Figures 6 through 9 are the cross sections developed using

stratigraphic information from soil borings completed at the Facility. The stratigraphic profile from the ground surface downward generally consists of the following:

- **Fill** – The buildings at the Facility were constructed on a formerly undeveloped property. Original topography (pre-development) and current topography indicated the Facility was generally covered with a few feet of fill on the eastern^(PN) side, but was cut on the western^(PN). Comparison of the two datums (main sea level at Sandy Hook; date not known and 1983 National Vertical Datum) is not possible; therefore, the cut and fill quantities cannot be determined.

The fill material consisted of various components including reworked silt, sandy silt material, reworked organic materials, and possible coal and ash. A review of historic topographic maps, grading plans, aerial photographs, and construction photographs, indicated that the Facility was regraded prior to original development and additional fill placement occurred as building expansion occurred.

Due to the potential presence of hazardous constituents in the fill material that are unrelated to Facility operations, the fill was further evaluated, as described in this report.

- **Glacial Till** – The next stratigraphic unit beneath the fill was observed to be a sandy to silty to clayey till commonly containing 5 to 20 percent pebbles, cobbles, and boulders of gneiss, sandstone, basalts and granite. These deposits contain few thin lenses of stratified gravel, sand and silt. Thickness of the till is generally 10 to 30 feet (USGS Map (2002)). At the Facility, this till is typically a medium-dense to dense red-brown silt. It contains some gravel, silty sand and poorly graded sand. This material becomes denser with depth.
- **Weathered Siltstone** - The next stratigraphic unit encountered beneath the till is a weathered red siltstone. This top of rock zone was, where encountered, between approximately 21 feet to 33 feet below ground surface (bgs), with an average depth of approximately 25 feet. This zone, defined as rock having less than 30% RQD (rock quality designation), varies in thickness from approximately 1 foot to 30 feet in the exploratory holes.

B. Bedrock

Information obtained during installation of the 17 weathered bedrock wells and 5 bedrock wells during the RFI/RI indicate weathered bedrock grades to competent bedrock, which consists of a red-brown, fine-grained siltstone (Passaic Formation) that occurred at a depth ranging from 33 to 69 feet bgs. Competent bedrock, for this investigation, has been defined as 30% or greater RQD. The depths at which the top of rock was completed during the RFI/RI are slightly different than these during investigation in the 1990s. Information obtained during the installation of four bedrock wells (BEC-1B through BEC-4B) at the Facility prior to this RFI/RI indicated that bedrock was encountered at depths ranging from 20 feet bgs to 30 feet bgs. This difference suggests the top of rock encountered in the wells drilled prior to RFI/RI investigation identified the top of the weathered bedrock not competent rock.

The interpreted bedding plane from boring logs and published literature indicate a range of strike of the bedding of north^(TN) 20 to 45 degrees east^(TN) and dip to the northwest^(TN) ranging between 5° to 15°. (USGS, 1996 Miscellaneous Investigation Series Map I -2540-A)

C. Hydrogeology

Groundwater at and in the vicinity of the Facility is present in three zones. These zones are characterized as overburden (shallow and deep), weathered bedrock and bedrock (semi-confined flow zone). The groundwater movement within these flow zones is in response to hydraulic gradients, with flow from areas of higher to lower hydraulic head.

Based on the RFI/RI investigation and as reported by Merck and Safety Kleen, groundwater flow in the overburden, weathered bedrock and bedrock is predominantly south^(TN) towards the Rahway River (refer to Figures 10,11, 13 and 14 and Appendix I - Merck & Safety Kleen Groundwater Contour Maps). In addition, groundwater investigations at the Facility indicate that there is generally a downward gradient from the overburden to the bedrock, with the exception of the MW-15 cluster which has exhibited a slight upward gradient.

The interpreted groundwater table elevation maps were developed from the well gauging data obtained during multiple occasions during the RFI/RI. Following installation of the wells during the Preliminary Groundwater Investigation, water levels from all existing wells (18 shallow overburden wells, 9 deep overburden wells, 4 weathered bedrock wells, and 7 bedrock wells) were gauged. The depth to water in existing wells was also gauged during 5 separate events during 2003 and 2004

approximately 2 months apart. Only during the December 2003 and March 2004 events were all wells (29 shallow overburden wells, 13 deep overburden wells, 17 weathered bedrock wells and 8 bedrock wells) gauged.

1. Overburden Groundwater

The overburden groundwater is generally comprised of an unconfined water-bearing unit consisting of fill material and glacial tills overlying higher permeability weathered bedrock. A summary of monitoring well construction is included in Table 3.06.1. Hydraulic conductivity tests from monitoring wells completed in the overburden generally indicate a range in permeability from 10^{-2} to 10^{-5} cm/sec, with a typical permeability on the order of 10^{-4} cm/sec (Table 3.06.2).

Monitoring wells located in shallow and deep zones in the overburden indicate that the overburden appears to behave as one saturated unit. Because of the vertical head gradient from the overburden to the bedrock, generally only the shallow overburden wells are used for the interpretation of the overburden potentiometric surface.

The gradient in the overburden is generally to the southwest^(PN). Anomalies exist west^(PN) of the Paint Mix Building (AOI 6) and in the vicinity of the former USTs (AOI 16). Near the Paint Mix Building, a localized flow regime appeared with an interpreted flow to the west^(PN). A mound is observed in the wells installed in AOI 16. This may be due to the more permeable fill placed in the former UST-excavation. The contour maps and ground water elevation data for these water bearing zones are shown on Figures 10 and 11.

Based on water level measurements from the wells during the RFI/RI, the overburden groundwater ranges from 7 feet to 16 -feet below ground surface depending on the location on the Facility and seasonal variation. A review of groundwater levels for the overburden taken during the period of RFI/RI implementation (July 2002 through March 2004), indicated that groundwater levels in the overburden wells have slight seasonal fluctuation on the order of two feet or less. Because the last two gauging events are the most inclusive, the potentiometric surface contours from these events are shown on Figures 10 and 11. Earlier interpretations exhibited similar general trends.

The following observations were noted:

- At the northern^(PN) portion of the Facility in the vicinity of the former USTs, the potentiometric surface contains a localized high, in or near

the former UST excavation. This feature had been backfilled with more permeable fill than the surrounding native materials creating a localized perched groundwater effect.

- To the west^(PN) of the former USTs (MW-15 cluster) a slight upward gradient is observed.
- On the western^(PN) portion of the Facility, localized flow to the west^(PN) is inferred from the potentiometric contours. The cause of this inferred flow is not known, but may be related to recent pumping by Merck or subsurface utilities.

Based on the above observations and groundwater flow paths, overburden groundwater flow appears to be controlled by surface water drainage (Rahway River and Arthur Kill) as well as underground utilities.

Based on a typical gradient of 0.002 from the March 2004 potentiometric surface contours, a typical permeability of the overburden on the order of 5×10^{-4} cm/sec, and an assumed porosity of approximately 30% (Freeze and Cherry, 1979), the average groundwater velocity is on the order of 0.5 feet per year.

2. Weathered Bedrock Groundwater

Groundwater generally flows to the southwest^(PN) across the Facility in the weathered bedrock based on the December 2003 and March 2004 gauging data. This flow observation has been consistent during the gauging events which are part of the RFI. MW-26W had not been surveyed prior to the December 2003 gauging. Its presence in the March 2004 measuring event creates a slight localized westerly^(PN) component of flow.

The weathered bedrock exhibits a permeability that ranges from 10^{-2} to 10^{-3} cm/sec with a typical permeability of approximately 5×10^{-3} cm/sec (Table 3.06.2). Observations during well installations identified a silty sand layer existing above the weathered bedrock at the bottom of the overburden. The vertical head at locations where weathered bedrock wells are coupled with overburden wells (S or D wells) (MW-15S and MW-15W, MW-16S and MW-16W, MW-17S and MW 17W, MW-18S and MW-18W, MW-20S and MW-8W, MW-22S and MW-22W, MW-26S and MW-26W, MW-31S and MW-31W, MW-33D and MW-33W, and MW-34S and MW-34W) indicate a downward component of flow. The head differences in these pairings range from 0.5 foot to 3 feet downward. The exception to this is at the MW-15 cluster where there is approximately 1.5 feet of upward head.

Based on water level measurements taken from the 17 weathered bedrock monitoring wells during March 2004, the potentiometric surface of the weathered bedrock groundwater ranges from 7 to 15-feet below ground surface, with a typical depth of approximately 12.5-feet. Potentiometric surface elevation contours of the bedrock groundwater from December 2, 2003 and March 3, 2004 are shown on Figures 13 and 14. The following observations were noted from the contours:

- Groundwater generally flows towards the south^(PN) to southwest^(PN) from a potentiometric high at MW-15W.
- The potentiometric surface contours indicate a downward gradient from the overburden to the bedrock water bearing zones across much of the Facility. However in the MW-15 cluster location the potentiometric surface contours indicate a neutral or upward gradient.

Based on a typical horizontal gradient of 0.002 from the December 2003 and March 2004 potentiometric surface contours, a typical permeability of the weathered bedrock on the order of 5×10^{-3} cm/sec, and an estimated weathered bedrock porosity of approximately 20% (Freeze and Cherry, 1979), the average horizontal groundwater velocity is on the order of two feet per year.

A review of groundwater levels for the weathered bedrock taken during the period of RFI/RI implementation (June 2002 to March 2004), indicated groundwater levels in the weathered bedrock wells had a slight seasonal fluctuation. The maximum to minimum variation was on the order of three feet or less.

As indicated above, the vertical gradient is downward from the overburden to the weathered bedrock then to the competent bedrock across much of the Facility, with the exception of the MW-15 cluster. However, due to the presence of the low permeability of the bedrock (10^{-6} cm/sec or less, based on packer testing), the vertical groundwater flux is anticipated to be significantly less than the horizontal. Based on a typical vertical gradient ranging from 0.3 to 0.03 from the March 2004 potentiometric surface contours, an average permeability of the top of rock on the order of 10^{-6} cm/sec or less, and a typical porosity of 20% (Freeze and Cherry, 1979), the vertical groundwater velocity is estimated to be 0.1 to 0.01 foot per year to the bedrock.

3. Bedrock Groundwater

Interpreted groundwater flow in the bedrock is southerly^(PN) based on December and March events. However, the distribution and depth of the existing bedrock wells suggests these wells may not be monitoring the same fracture zones across the Facility, and therefore, may not have comparable water level elevations.

Monitoring wells in the bedrock were packer tested and evaluated using downhole geophysical techniques (BEC-1B, 2B, 4B, and MW-16B, 17B and 18B). Appendix J contains the information collected from this investigation. In summary, water-producing fractures were minimal in the bedrock wells. Fractures identified in MW-18B were considered near vertical at the top of the borehole. This is consistent with the packer testing of this borehole. However, the test results did not record any flow into the well below 53 feet bgs in MW-18B. Similarly, for BEC-2B a near vertical fracture was noted to yield approximately 0.03 gpm near the bottom of the borehole. Again, this is consistent with the packer testing of this hole.

The hydraulic conductivity of the competent rock, as measured by packer testing (Table 3.06.3), is low (10^{-6} cm/sec or less). In many of the tests, the borehole did not take water, therefore, a hydraulic conductivity could not be calculated. As noted above, both BEC-2B and MW-18B did take water in specific intervals of the open borehole. The hydraulic conductivity of these fracture intervals was observed to be approximately 10^{-4} cm/sec from the packer testing.

3.07 Background Soil Characterization

As a conservative assumption, all concentrations of organic and inorganic constituents are assumed to be site-related, since the RFI/RI field investigation did not attempt to establish a site-specific background level for any constituent.

3.08 Land Use and Demographic Data

A. Population

The Facility is situated within Union County, New Jersey, a highly developed area with residential areas, and industrial and commercial facilities.

As of mid-2004, approximately 1300 people work at the Facility.

The 2000 census indicated the following:

- The population of Linden, New Jersey is 39,394 up from 36,701 (1990)
- The number of housing units in Linden is 15,567 up from 14,369 (1990)
- The population of Rahway is 26,500 up from 25,325 (1990)
- The number of housing units in Rahway is 10,381 up from 9,623 (1990)

Facility workers, trespassers, utility workers and residents are potential receptor populations under the current land use scenario. The current exposure pathways are expected to be equivalent under the potential future land use scenario.

B. Surrounding Land Use

1. Existing Land Use

The GM Linden Facility is situated within a commercial and industrial area of Linden, with some residential development immediately adjacent to the Facility to the south^(TN). The Rahway River is located approximately 1-mile to the south^(TN) of the Facility. Two smaller water bodies are within a ½-mile radius of the Facility. A land use map is provided as Figure 2.

Surrounding properties include:

- West Edgar Road (U.S. Route 1 and 9) and Linden Airport are located to the east^(TN). Adjacent to Linden Airport to the south^(TN) is Safety Kleen, a facility that recovers spent organic solvents, and other industrial facilities;
- A commercial area and Stiles Street are located to the northeast^(TN);
- Linden Avenue and railroad tracks are located to the northwest^(TN) with mixed commercial and industrial activity located northwest^(TN) of the tracks;
- A cogeneration facility is located to the southwest^(TN); and
- Pleasant Street and GM parking lots are located to the south-southwest^(TN). Adjacent to the parking lots is the Merck Corporation, a pharmaceutical manufacturing company, as well as a small residential area.

According to information in the NJDEP files, both Merck Corporation (identified as Site No. NJD 002182897) and Safety Kleen (identified as Site No. NJD 002186690) have impacted groundwater. These sites are currently being investigated and remediated with oversight of the NJDEP. In addition

to these sites, there are approximately 15 additional sites on the NJDEP Known Contaminated Site List within ¼-mile radius of the Facility.

The current activities of the Facility and as noted above are consistent with the current zoning for Linden, New Jersey as noted in Figure 2.

2. Future Land Use

The Facility is currently zoned as Heavy Industrial and is currently used for vehicle manufacturing. Surrounding areas are zoned for commercial/industrial or residential use. The nearest residential land is immediately the south^(TN) of GM owned property currently used as parking lot. No hospitals are located within 1/2 mile of the Facility. A land use map is provided as Figure 2.

A review of the City of Linden's Master Plan (2000) indicates the GM Facility will remain zoned as a mixture of LI and HI (Light and Heavy Industrial). The land use in the immediate surrounds will also stay as currently zoned. At this time the City does not recognize nor indicates that there will be any future change in use in this area.

3.09 Groundwater Use

A. Potable Water Supplies

Elizabethtown Water Company is the provider of potable water to the City of Linden. It has indicated it delivers potable water to all businesses and residence within one mile of the Facility (Appendix K).

Elizabethtown Water Company indicates the water supply it uses to provide water to Linden comes from the following surface water sources:

- Raritan River
- Millstone River
- D&R Canal

B. Groundwater Use

A well search was conducted in June 1994 and updated it in 2003 and 2004 in order to identify potential receptors in the neighborhood surrounding the GM-Linden Facility. The search included locating private permitted wells and public/industrial water

supply wells within one mile of the GM Linden Facility. Information regarding wells and other water withdrawal points within the 1-mile search radius were obtained from the NJDEP, Division of Water Resources - Bureau of Water Allocation. Information provided by the NJDEP for wells within the 1-mile search radius is summarized in Appendix K (not including outside the one mile search area). Through the use of the NJDEP information, the following were identified within one mile of the Facility: 5 domestic wells within one mile of the Facility (not including documented abandoned wells), 7 industrial wells, 2 injection wells, 1 private well (use unknown), 54 recovery wells, 1 test well, and 2 unknown use wells (Table 3.09.1).

1. The Linden Health Department and Union County Regional Environmental Health Commission were also contacted for information pertaining to the wells identified by the NJDEP and any additional groundwater wells within the 1-one-mile search radius of the Linden Facility. The Linden Health Department indicated that although numerous monitoring wells exist, no drinking water wells are present within one mile of the Facility and that residences are connected to a public water supply. The statements made in the Merck and Safety Kleen reports confirm this information (Merck, 1994 and Merck, 2001). The Union County Regional Environmental Health Commission was unable to supply any information regarding groundwater wells in the area.

Of the five domestic and seven industrial wells, the following information pertains:

- Range of well depth: 119 to 510 feet below ground surface.
- Casing length range: 28 to 80 feet below ground surface.
- Open borehole length, Range: 70 to 510 feet
- Static water level range: 10 to 50 feet below ground surface.

These wells are open borehole below the casing. Casing typically is across overburden and set into rock. Rock is described in the drillers log for three wells as "red shale" (referred to as the red siltstone bedrock during the RFI/RI work).

Table 3.6 summarizes information on these wells. Follow-up with Linden Health Department and discussions with current owners or operators indicated only one of these wells is known to exist (Well no. 17) and it is used for washing machines in a laundromat.

3.10 Ecological Setting

The Facility and the immediate surrounding area have been significantly developed with much of the ground surface covered by buildings and pavement which consist of commercial and industrial facilities, residential communities, and public roadways. In particular, the Facility is virtually entirely covered by buildings or pavement. A review of the National Wetlands Inventory maps for the area around the GM-Linden Facility (Elizabeth and Perth Amboy Quadrangles) indicates that the Facility is not located within a wetland area. A Wetlands Map is provided as Figure 15. The Baseline Ecological Evaluation, contained in Appendix L, provides detail on the ecological setting surrounding the Facility.

IV. INVESTIGATION RESULTS AND EVALUATION

The results of the field investigations conducted during the RFI/RI are discussed in this section. The discussion is divided into subsections that correspond to the AOIs that were investigated. Each subsection includes a brief description of the AOI, the scope of the field investigations, a summary of the results, and discussion of the results with respect to whether a potentially significant release of hazardous constituents has been identified, and if so, the nature and extent of the release for risk evaluation purposes.

The presence of a potentially significant release at an area was identified during the RFI/RI field investigation based on comparison of the Facility characterization data for soil, groundwater, sediment, and surface water with conservative, generic screening criteria. Where a potentially significant release was identified, the screening criteria were then used to guide characterization of the extent of the release for risk evaluation purposes in the affected media. The screening criteria used for evaluating the RFI/RI Facility characterization data are discussed in Sections 4.0.1 to 4.0.4.

Results of the data comparison are summarized in tables and are also shown on Figures 16 to 22, (databox figures), which are used to facilitate discussion of the characterization results for each investigated area in Sections 4.06 to 4.27. A discussion on the use of the screening criteria for evaluating RFI/RI data quantitatively on the screening summary tables and spatially on the figures is provided in Section 4.05.

4.01 Soil Screening Criteria

The soil characterization data were compared with the following three types of soil screening criteria: 1) criteria based on direct contact with soil; 2) criteria based on vapor intrusion, and 3) criteria based on migration of soil constituents to groundwater.

A. Direct Contact

The primary set of direct contact soil screening criteria used to guide the RFI/RI field investigation was derived from the USEPA Region 9 risk-based preliminary remediation goals (PRGs) for industrial soil (USEPA 2002). USEPA Region 9 calculated these PRGs using conservative exposure factors for estimating high-end exposure of workers via incidental ingestion, dermal contact, and inhalation of airborne soil constituents in commercial/industrial settings. The risk-based PRGs published by USEPA Region 9 are based on a target cancer risk of 10^{-6} and a target hazard quotient (HQ) of 1.

These PRGs were chosen as the basis for deriving the primary set of direct contact soil screening criteria because they are based on an exposure scenario that is consistent with the current and reasonably expected future land use at the Facility (see discussion in Section 3.08). The exposure factors used in these USEPA Region 9 PRGs are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are expected to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of worker populations.

The target cancer risk of 10^{-6} used in the USEPA Region 9 cancer-based PRGs is based on the assumption that workers at a site would be exposed to a large number of carcinogenic chemicals in soil. According to USEPA, a target risk of 10^{-6} can be used to develop soil screening criteria (like the PRGs) to ensure that cumulative cancer risk from exposure to multiple human carcinogens in soil at a particular site would not exceed the acceptable cumulative risk limit of 10^{-4} (61 FR 19432, May 1, 1996; USEPA 1996; USEPA 1991). Using a target cancer risk of 10^{-6} actually means that an individual can be simultaneously exposed to as many as 100 human carcinogens at concentrations equal to the PRGs, and the cumulative cancer risk estimate for the exposure would not exceed 10^{-4} .

At many sites, including at this Facility, workers are potentially exposed to far fewer human carcinogens in soil (i.e., closer to 10 than 100) so that the PRGs calculated using a target cancer risk of 10^{-6} are far more conservative than necessary to protect for simultaneous exposures to multiple carcinogens in soil. As such, the cancer-based PRGs were adjusted to a target cancer risk of 10^{-5} before they were used as screening criteria for guiding the RFI/RI field investigation at this Facility. The appropriateness of making this adjustment was verified by calculations of cumulative cancer risks based on actual RFI/RI soil characterization data, which are discussed in Section 5.

A secondary set of direct contact soil screening criteria was also considered during the RFI/RI field investigation. These criteria were the NJDEP Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) (Proposed Rule NJAC 7:26D, 1992). The NRDCSCC are generally health-based criteria that are based on exposure of workers to soil via incidental ingestion and inhalation of airborne soil constituents (no dermal contact), and are calculated using a target cancer risk of 10^{-6} and a target HQ of 1. However, the NRDCSCC for some chemicals are not health-based, but are based on either ecological endpoints, practical quantitation limits, or default background concentrations. The NRDCSCC were used as a secondary set of screening criteria because they are not entirely health-based, and the criteria that are health-based were generally not derived using up-to-date risk assessment methodology and/or toxicity information.

B. Vapor Intrusion

The vapor intrusion soil screening criteria were derived to identify soil conditions that might result in the exposure of workers to indoor air concentrations higher than occupational inhalation limits if constituents in the soil were to volatilize and migrate through building foundation cracks into indoor air. These criteria were derived using a vapor intrusion modeling approach recommended by USEPA (2003) for screening-level analysis. The model parameters related to soil properties were based on Facility-specific soil conditions and those related to building characteristics were based on conservative regulatory default assumptions for a hypothetical commercial/industrial building. The vapor intrusion criteria were calculated using permissible exposure limits (PELs) established by the Occupational Safety and Health Administration (DHHS 1997), or threshold limit values (TLVs) recommended by the American Conference of Government Industrial Hygienists (ACGIH 2003) for chemicals without PELs. Derivation of these screening criteria is discussed in Appendix M.

C. Migration to Groundwater

The migration to groundwater soil screening criteria were derived using the procedure outlined in USEPA's Soil Screening Guidance, and incorporate a default dilution-attenuation factor of 20 (USEPA 1996). Additionally, the NJDEP Impact to Groundwater Soil Cleanup Criteria (IGWSCC) (Proposed Rule NJAC 7:26D) were also considered during the RFI/RI field investigation. Both sets of criteria are based on the protection of groundwater as a drinking water source, and therefore, are highly conservative because overburden groundwater at the Facility and in its downgradient vicinity is not a current or reasonably anticipated source of drinking water (as discussed in Section 3.09).

4.02 Groundwater Screening Criteria

The groundwater characterization data collected from monitoring wells were compared with the following three types of groundwater screening criteria: 1) criteria based on drinking water consumption; 2) criteria based on vapor intrusion, and 3) criteria based on construction worker contact with groundwater.

A. Drinking Water

The drinking water criteria were based on state or federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act, and equivalent drinking water concentrations for constituents without MCLs. The equivalent drinking water concentrations are generic risk-based drinking water limits calculated using conservative standard default exposure factors for estimating high-end

exposures via daily drinking water consumption (USEPA 1991), and target cancer risk and target HQ of 10^{-5} and 1, respectively. The groundwater monitoring data were also compared with the NJDEP Groundwater Quality Standards for Class IIA groundwater, which are applicable to groundwater that is used as a potable water supply (NJAC 7:9-6).

As discussed in Section 3.09, groundwater at and downgradient of the Facility is not a current or reasonably expected future drinking water supply. Therefore, use of the drinking water criteria to guide the RFI/RI field investigations was highly conservative.

B. Vapor Intrusion

Two sets of groundwater screening criteria based on vapor intrusion were derived to identify groundwater conditions that might result in potentially significant indoor air exposures if constituents in groundwater were to volatilize and migrate through cracks in building foundations into indoor air. One set of these criteria was used to identify such groundwater conditions on-Facility, and were derived in a manner similar to the derivation of the vapor intrusion criteria for soil. These criteria were derived using the same vapor intrusion modeling approach, the same soil properties, the same building characteristics, and the same PELs/TLVs. These criteria were used to evaluate groundwater data collected from on-Facility monitoring wells screened at or near the water table, since groundwater quality nearest the water table is the most appropriate for evaluating the potential for vapor intrusion.

The second set of criteria was used to identify the potential for significant vapor intrusion downgradient of the Facility. These criteria were derived in a manner similar to the derivation of the on-Facility criteria, except the building characteristics were based on conservative regulatory default assumptions for a hypothetical residential building, and they were calculated using USEPA-derived inhalation unit risk factors (URFs) and inhalation reference concentrations (RfCs). These criteria were used to evaluate groundwater data collected from the most downgradient on-Facility monitoring wells screened at or near the water table, since the installation of off-Facility monitoring wells has not been necessary during the RFI/RI to date. Derivation of both sets of vapor intrusion screening criteria for groundwater is discussed in Appendix M.

C. Construction Worker Contact

The groundwater screening criteria based on construction worker contact were derived to identify conditions in overburden groundwater that might result in significant exposure of construction workers during excavations that extend into the water table. These criteria were derived using conservative exposure factors for

incidental ingestion, dermal contact, and inhalation of vapors from groundwater. They were calculated using a target cancer risk of 10^{-5} and a target HQ of 1. Derivation of these screening criteria is discussed in Appendix M.

4.03 Sediment Screening Criteria

Generic risk-based screening criteria for evaluating the significance of potential exposure to sediments are not well established. Therefore, as a conservative approach to the identification of a potentially significant release to sediment, the sediment characterization data collected during the RFI/RI were compared with the generic risk-based screening criteria described above for evaluating direct contact exposures to soil.

Specifically, sediment samples collected from storm sewer catch basins were compared to the soil screening criteria derived from the USEPA Region 9 industrial soil PRGs and the NJDEP NRDCSCC. Sediment samples collected from Morses Creek were compared with soil screening criteria derived from the USEPA Region 9 residential soil PRGs and with the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC) (Proposed Rule NJAC 7:26D). Use of these soil screening criteria for evaluating potential exposures to sediments is highly conservative because potential exposures to sediments are expected to be much lower than potential residential exposures to soil.

4.04 Surface Water

Water samples were collected during the RFI/RI from the Facility's storm sewers and from Morses Creek, as discussed in Section 4.17. Generic risk-based screening criteria for evaluating the significance of potential exposure to surface water are not well established. Therefore, as a conservative approach to the identification of a potentially significant release to surface water, the storm water and surface water characterization data were compared with the groundwater screening criteria that are based on drinking water consumption.

4.05 Interpretation of Screening Results

As explained in the introductory text in Section 4.0, the screening criteria discussed above were used during the RFI/RI field investigation to guide data collection. Soil, groundwater, sediment, and surface water data collected from each phase of the field investigation were compared with the screening criteria to facilitate judgment regarding whether sufficient characterization data have been collected to support a risk assessment to determine whether corrective measures are warranted.

As such, the comparison results were used during the RFI/RI field investigation to distinguish constituents, media, and areas where further data collection should be considered from those

where further data collection is not necessary. The comparison results were not used to eliminate constituents, media, or areas from a baseline risk assessment. All constituents positively identified in soil, groundwater, sediment, and surface water at the Facility and all investigated areas are included in the baseline risk assessment discussed in Section 5.

The comparison results for each investigated area are presented in both screening summary tables and on databox figures. For each investigated area, the comparison results for each matrix are presented on a separate screening summary table, which lists all the target constituents, the number of analysis for each constituent, the number of detections, the range of detected concentrations, the screening criteria, and the ratios of the highest detected concentration for each constituent to the screening criteria. An area is identified to have a potentially significant release if it has at least one ratio that exceeds 1.

To facilitate judgment regarding whether the lateral and vertical extent of a potentially significant release has been adequately characterized, the data for certain constituents were selected for display on databox figures. The constituents chosen for databox display included all constituents with at least one concentration that exceeds any screening criterion in any matrix anywhere at the Facility. Every concentration of these constituents at every sample location are shown on the databox figures, and each concentration that exceeds a screening criterion is coded (i.e., marked with one or more codes to indicate the specific criteria it exceeds) to facilitate spatial assessment of concentration distributions.

The coding of soil concentrations on the databox figures includes a code that is based on an additional set of soil screening criteria that was developed at the end of the RFI/RI field investigation completed to date for the purpose of evaluating the adequacy of characterization for soil deeper than 2 ft below ground surface. These risk-based criteria are based on an exposure scenario in which construction workers are exposed via incidental ingestion, dermal contact, and inhalation of airborne soil constituents during excavation activities. These criteria were calculated using a target cancer risk of 10^{-5} and a target HQ of 1. Derivation of these criteria is discussed in Appendix M.

This additional set of soil screening criteria was not used during the field investigations to guide data collection. As discussed above, soil characterization was guided by using the soil screening criteria discussed in Section 4.01. For several constituents (primarily polycyclic aromatic hydrocarbons, or PAHs, and lead) at several locations on the eastern^(PN) side of the Facility (primarily near AOI 10 and AOI 11), the soil characterization effort extended to the Facility boundary after several phases of sampling that were guided by using the direct contact soil screening criteria discussed in Section 4.01.A. The concentrations of these constituents generally decreased toward the Facility boundary but a few concentrations in subsurface soil (deeper than 2 ft below ground surface) at the Facility boundary are slightly higher than the direct contact criteria that were derived from the PRGs. However, the direct contact criteria

are based on daily worker contact with surface soil, and therefore, are more conservative than necessary for evaluating occasional construction worker contact with subsurface soil. As such, the criteria specific to construction worker exposures were developed and used to evaluate these subsurface concentrations, and to facilitate judgment regarding the adequacy of the sampling effort at these locations.

The databox figures also include soil constituents that do not have concentrations that exceed any of the screening criteria discussed in Section 4.01. The additional constituents were included on the databox figure because they have at least one concentration in soil that exceeds the soil screening criteria derived from the EPA Region 9 "residential soil" PRGs or the NJDEP RDCSCC. These additional constituents were included to provide the option of conducting spatial assessment for a broader group of soil constituents. However, concentrations that exceed only the residential screening criteria are not highlighted, to keep the databox figures more useful for their primary purpose.

In addition to groundwater data collected from monitoring wells, grab samples of overburden groundwater were collected during the RFI/RI at some areas to guide field investigations of groundwater quality. These include: 1) borehole water samples collected from some soil borings that extended to the water table; 2) an aqueous sample collected below the LNAPL identified in a monitoring well; and 3) an aqueous sample from a sump in a wheel alignment pit inside the main plant building at the Facility.

Although the procedures for collecting these grab groundwater samples were intended to minimize the potential for introducing contaminants (including soil particles and NAPL) into the sample by the sampling procedure itself, such influence could not be entirely eliminated due to the nature of the sample collection method. As such, these aqueous data do not necessarily represent groundwater quality at the water table. Therefore, these data were not used as bases for identifying the presence of a potentially significant release, but rather were used only to guide decisions regarding groundwater characterization. However, these data were compared with the screening criteria described above for groundwater, and the comparison results have been included on screening summary tables as a point of reference.

4.06 AOI 3 - Existing Drum Storage Area/Fill Area

AOI 3 consists of two areas—the Facility's active drum storage area and a fill area. These areas were combined into a single area of investigation for the RFI/RI because of the overlap in their locations, as shown on Figure 16a. The two areas associated with AOI 3 are described below:

Drum Storage Area (SWMU 2)

The drum storage area, designated as SWMU 2 in the EPI/PA, was built in 1985 and is located on the southwestern ^(PN) portion of the fill area. The Facility uses the drum storage area for less-than-90-days storage of RCRA hazardous waste in accordance with 40 CFR Part 262. The drum storage area is approximately 20 feet by 50 feet and is entirely paved with an asphalt floor that is surrounded by a 6-inch curb, which meets the requirements for secondary containment under 40 CFR 262.34.

Fill Area

The fill area is approximately 100 feet by 200 feet and is entirely covered by asphalt pavement. The elevation of this area is approximately 5.5 feet higher than the surrounding area. As discussed in the CCR/PAR, interviews with Facility employees did not resolve the source of the fill material or when the fill material was placed in the area. However, a historical topographical map of the Facility suggests that the fill material might have been placed during Facility preparation in advance of the Facility's construction in 1936. The southwestern ^(PN) portion of this area underlies the drum storage area.

A. Scope and Results

The scope of the RFI/RI field investigations at AOI 3 involved the collection of soil and groundwater samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at SWMU 2 or pre-RCRA placement of fill material in the fill area. The RFI sampling locations and results for soil and groundwater are shown on Figures 16a, 17a, 18a, 18b, 18c, 18d, 19a, 19b, and 19c.

The following is a summary of the sampling activities conducted for each medium during the RFI/RI at AOI 3:

Soil Samples

During the initial phase of the RFI field investigations, three soil borings (AOI 3 B-1 to AOI 3 B-3) were installed at AOI 3 to provide even coverage of the area, as proposed in the RFI/RI Work Plan. Soil samples from these locations were collected at depth intervals in accordance with the criteria described in Sections 7.1.1 and 7.2.2 of the RFI/RI Work Plan. Each of the soil samples were analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals.

Based on potentially significant concentrations of certain PAHs (primarily benzo(a)pyrene) detected in the surface sample at boring AOI 3 B-2, additional soil boring locations (AOI 3 B-4 and AOI 3B-5) were sampled during the next

phase of field investigations to further characterize the extent of PAHs in surface soil.

During installation of shallow monitoring well MW-21S, which is located at the southwestern ^(PN) corner near the east side of Pleasant Street, soil samples from three depth intervals were collected in accordance with the criteria described in the RFI/RI Work Plan, and analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals. Monitoring well MW21-S was installed during the RFI/RI to investigate overburden groundwater quality in the vicinity of BEC-4B. Based on the potentially significant concentrations of chromium (total) and manganese in the surface soil sample from this location (MW-21S B-1), additional soil boring locations (AOI 3 B-6 and AOI 3 B-7) were completed during a subsequent phase of field investigation to further characterize the extent of metals in surface soil. Samples collected from these points were also analyzed for PAHs to supplement the data for PAHs from borings AOI 3 B-1 to AOI 3 B-5.

Note that boring AOI 3 B-7 is located on the west ^(PN) side of Pleasant Street, which is actually outside the AOI 3 boundary, as shown on Figure 1a. This boring was installed at this location to verify that the extent of metals concentrations found at MW-21S B-1 (and PAH concentrations at B-2), which appear to be associated with the pre-RCRA fill material, does not extend across Pleasant Street.

Groundwater Samples

Groundwater samples were collected during the RFI/RI from the following monitoring wells: MW-21S, BEC-9D, MW-36W, MW-37W, and BEC-4B. Monitoring wells BEC-9D and BEC-4B were installed prior to the RFI/RI investigations at the Facility. Monitoring wells MW-36W and MW-37W were installed during the RFI/RI to investigate possible interactions between groundwater quality in the weathered bedrock zone and groundwater in BEC-4B. BEC-4B was originally intended to monitor groundwater in the shallow bedrock.

The shallow overburden monitoring well MW-21S was analyzed for TCL VOCs and TAL metals. The other monitoring wells were analyzed for TCL VOCs, TCL SVOCs, and TAL metals. During the RFI/RI, monitoring wells BEC-9D and BEC-4B were also analyzed for PCBs.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Metals
Soil	8	11	18	8	15
Groundwater	5	9	6	2	7

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.06.1 to 4.06.3. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 2 and whether potentially significant concentrations of hazardous constituents are present in the pre-RCRA fill material in the fill area. The results of the comparison are summarized in Tables 4.06.1 and 4.06.2 and shown on Figures 16a, 17a, 18a, 18b, 18c, 18d, 19a, 19b, and 19c. These results were used during the RFI/RI field investigation to guide data collection.

Soil

Table 4.06.1 and Figure 16a indicates that certain PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) have concentrations in soil at AOI 3 that are higher than the screening criteria discussed in Section 4.01.A (based on direct contact). These concentrations are localized to the surface soil at boring AOI 3 B-2; the concentrations of these PAHs at all the other boring locations and depths are lower than the screening criteria.

Table 4.06.1 also indicates that chromium (total) and manganese have concentrations in soil at AOI 3 that are higher than the screening criteria discussed in Section 4.01.C (based on migration to groundwater). The concentrations of chromium were found at borings AOI 3 B-2 and MW-21S B-1, while the concentrations of manganese were found at only MW-21S B-1, as shown on Figure 17a. The high chromium (total) concentration at AOI 3 B-2 was found in the surface sample only; the concentrations in the two deeper samples

are lower than the screening criteria. At MW-21S B-1, the chromium and manganese concentrations in the deepest sample interval (just above the water table) are approximately four times higher and approximately the same as their respective screening criteria.

No soil samples at AOI 3 had concentrations higher than the screening criteria discussed in Section 4.01.B (based on vapor intrusion).

Groundwater

Table 4.06.2 and Figures 18a, 18b, and 19a indicates that manganese is the only constituent that has a concentration in shallow overburden groundwater (at MW-21S) that is higher than the screening criteria discussed in Section 4.02.A (based on drinking water). This concentration of 0.613 mg/L is higher than only the NJDEP Groundwater Quality Standards for Class IIA groundwater, which for manganese is an aesthetics-based rather than a health-based criterion. This manganese concentration is lower than the risk-based drinking water criterion of 0.88 mg/L. The groundwater data at MW-21S indicate that the high chromium and manganese concentrations in soil at this location have not adversely affected groundwater quality.

No constituent has a concentration in shallow overburden groundwater at AOI 3 that is higher than the criteria discussed in Sections 4.01.B (based on vapor intrusion) and 4.01.C (based on construction worker contact).

In the deeper overburden groundwater (at BEC-9D), TCE and manganese are the only constituents that have concentrations higher than the screening criteria (based on drinking water). The TCE concentrations (which range from 0.0013 to 0.0024 mg/L among the three samples collected from BEC-9D) are only slightly higher than the state MCL of 0.001 mg/L and are lower than the federal MCL of 0.005 mg/L. The manganese concentration was 0.409 mg/L and 14.5 mg/L in the samples collected on 1/29/2003 and 10/23/2003. This large change in the manganese concentration is unusual and may not be representative of an actual change of such magnitude in groundwater quality; no change of similar magnitude was evident in the concentrations of any other constituent. Additional samples will be collected to confirm the change in concentrations.

As indicated in Table 4.06.3 and Figures 18c and 19b, in the weathered bedrock groundwater (at MW-36W and MW-37W), ten TCL VOCs, bis(2-chloroethyl)ether (BCEE), arsenic, and manganese have concentrations that are higher than the screening criteria (based on drinking water). The following TCL VOCs have concentrations at least 10 times higher than the screening criteria at

MW-36W: benzene, 1,2-DCA, PCE, and TCE. The only constituent with a concentration higher than 10 times the screening criteria at MW-37W is TCE, although the concentration at this well (0.021 mg/L) is about 50 times lower than that at MW-36W (1.1 mg/L).

As shown on Figures 13 and 14, MW-36W is the furthest upgradient monitoring well that has been installed to date in the weathered bedrock along the northwestern^(PN) Facility boundary. During installation of this well, no field evidence of soil contamination was observed, so no soil sample was collected. The absence of apparent soil contamination at this location in combination with the high concentrations of TCL VOCs in groundwater suggest a need for installation of additional weathered bedrock monitoring wells upgradient of MW-36W at on-Facility and off-Facility locations to identify the source of TCL VOCs.

As indicated in Table 4.06.3 and Figures 18d and 19c, in the bedrock groundwater (at BEC-4B), thirteen TCL VOCs, BCEE, and manganese have concentrations that are higher than the screening criteria (based on drinking water). The following TCL VOCs have concentrations at least 10 times higher than the screening criteria: benzene, 1,2-DCA, methylene chloride, PCE, TCE, vinyl chloride, and BCEE. The benzene, methylene chloride, and vinyl chloride concentrations in BEC-4B are at least 10 times higher than their concentrations in the weathered bedrock wells.

The 1,2-DCA, PCE, TCE and BCEE concentrations in BEC-4B are approximately the same as or somewhat higher than those in the weathered bedrock monitoring well MW-36W, which is located approximately 140 feet to the north^(PN). According to Figures 13 and 14, groundwater in the weathered bedrock at MW-36W flows in the weathered bedrock zone in the direction of well BEC-4B. Possible interaction between groundwater in the weathered bedrock zone and groundwater in well BEC-4B is further discussed in Section 4.27.

The following organic compounds are notable because they were detected in weathered bedrock and/or bedrock groundwater at concentrations higher than the groundwater screening criteria but were not detected at concentrations in soil that are higher than any soil screening criteria anywhere at the Facility: carbon tetrachloride, chloroform, 1,2-DCA, 1,1-DCE, trans-1,2-DCE, PCE, 1,1,2-TCA, vinyl chloride, and BCEE. These compounds also were not detected in overburden groundwater at concentrations higher than any groundwater screening criteria anywhere at the Facility, except PCE (at 0.002 mg/L at MW-24S in AOI 7) and vinyl chloride (at 0.0036 mg/L and 0.0088 mg/L at MW-38S and MW-39S in AOI 6). The absence of these constituents in soil and the virtual absence of

these constituents in overburden groundwater across the entire Facility suggest that the presence of these constituents in the weathered bedrock and bedrock groundwater is likely unrelated to operations at AOI 3 or at the Facility. In addition, BCEE, a reagent used in organic synthesis (e.g. pharmaceutical manufacture) was not used at the Facility.

Further discussion of the RFI/RI groundwater results across the entire Facility for each saturated zone is provided in Section 4.27.

C. Conclusions

The soil data collected during several phases of RFI/RI field investigations at AOI 3 indicate that potentially significant concentrations of certain PAHs are present in surface soil at only one localized area (AOI 3 B-2) within AOI 3. The soil data also indicate that chromium (total) and manganese are present in soil at one location (MW-21S) at concentrations that could adversely affect groundwater quality. The presence of these concentrations of PAHs and metals are believed to be associated with the pre-RCRA fill material rather than a release from operations at the drum storage area (SWMU 2), since these constituents are relatively immobile in the environment and the secondary containment for the drum storage area would prevent any release to the underlying soil.

Overburden groundwater data at MW-21S indicate that the high chromium and manganese concentrations in soil at MW-21S have not affected groundwater quality. The overburden groundwater data at AOI 3 do not indicate any significant release to groundwater from soil at AOI 3. Many constituents (primarily TCL VOCs) at high concentrations were found in the weathered bedrock and bedrock groundwater monitoring wells at AOI 3. However, the source of these constituents does not appear to be related to AOI 3. Several of the constituents do not appear to be related to the Facility at all, based on their absence or near absence in soil and overburden groundwater samples collected across the entire Facility.

Further field investigations to identify the source of the high TCL VOC concentrations found in the weathered bedrock and bedrock monitoring wells at AOI 3 are being conducted at on-Facility and off-Facility locations. In addition, the large change in manganese concentrations at BEC-9D will be confirmed with additional samples. The results from these investigations will be reported in an addendum to this RFI/RI Report.

4.07 AOI 5 – Former ELPO USTs

AOI 5 formerly contained two USTs used to store ELPO, a black primer. The USTs were located in the area of the former test track, which is now within the Facility building footprint. Interviews with GM employees suggested that the USTs were taken out of service in the 1960s, during building expansion activities. However, it is unknown whether the USTs were closed in place or removed prior to the Facility building addition over the area. The exact location of the former tanks USTs is not known. No previous soil or water quality samples have been obtained for this AOI.

A. Scope and Results

As detailed in the RFI/RI Work Plan, the scope of the RFI/RI field investigation at AOI -5 was limited to an evaluation of the Facility-wide groundwater results to determine if lead concentrations increased from upgradient to downgradient at this AOI. The groundwater lead results from upgradient monitoring wells, BEC-13S, BEC-5D, MW-15S, MW-15W, and MW-15B were compared against the results from downgradient monitoring wells MW-21S, MW-31S MW-31W, and MW-37W to determine if further evaluation of this AOI was necessary. No soil samples were obtained during the RFI/RI investigation from this AOI.

The monitoring well locations and groundwater results summary are shown on Figures 19a, 19b, and 19c. The analytical data is summarized in Table 4.07.1 and in Appendix E. The analytical data was reviewed and validated, a summary of the validation is provided in Appendix G.

B. Discussion of Results

The concentrations of lead detected in groundwater were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The data for the upgradient and downgradient wells are shown on Figures 19a, 19b, and 19c. The groundwater data upgradient and downgradient of this AOI do not show an increase of lead across the AOI. Lead concentrations in the wells upgradient of AOI 5 range from below detection limits to 0.0017 mg/L. Lead concentrations in the downgradient wells range from below detection limits to 0.00029 mg/L. All results are below the screening criteria discussed in Section 4.02.A (based on drinking water). Based on the comparison, additional investigation was not warranted.

C. Conclusions

RFI/RI groundwater data collected upgradient and downgradient of AOI -5 are all below screening criteria, which indicates that a potentially significant release of

hazardous constituents has not occurred from these former tanks. Additional investigation and evaluation of this AOI is not warranted.

4.08 AOI 6 – Paint Mix Building

AOI 6 consists of Paint Mix Building and its immediate surrounds. The Paint Mix Building was constructed in the mid-1960s, during a plant expansion. As discussed in the CCR/PA, this AOI includes SWMU 4 and SWMU 6 identified in the EPI/PA, which are inside the building. This AOI contains two 12,000-gallon and three 6,000-gallon steel ASTs. As defined in the EPI/PA, SWMU 4 is a 12,000-gallon AST currently used for storing paint and purge solvent from spray gun cleaning prior to reclamation. The second 12,000-gallon tank contains raw ELPO resin. SWMU 6 is a 6,000-gallon vertical AST storing paint and purge from spray gun cleaning. This interior AST was active from 1979 to 1986 and decommissioned in 1989. The other two 6,000-gallon vertical tanks are used to contain new paint thinner.

The AOI is active and all ASTs are provided with impermeable secondary containment separate from the floor drain/sump system. Secondary containment is provided for the entire building by concrete floors and walls. Floor drains or concrete curbs, located at doorways, block possible discharge routes to the building exterior. The floor drains are connected to a concrete holding sump with capacity sufficient to contain the largest possible leak. The floor was intact and no signs of floor repairs were noted during the Facility visits.

As reported in the CCR/PA, no reported/documented historic use of the Facility prior to construction of the Paint Mix Building in 1964 was identified. No previous investigations of soil or water quality for this area had been conducted. Review of aerial photographs for the Facility indicate this area may have had some limited use prior to the construction of the Paint Mix Building.

A. Scope and Results

The scope for the RFI/RI field investigation at AOI 6 included the collection of soil and groundwater samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of past or current operations at the Paint Mix Building. The RFI/RI sampling locations for soil and groundwater are shown on Figures 16b, 17b, 18a, 18b, 18d, 19a, and 19c.

The following is a summary of the sampling activities performed for each medium during the RFI/RI at AOI 6:

Soil

During Stage I of the RFI/RI field investigation, two soil borings (AOI 6 B-1 and AOI 6 B-2) were drilled. As discussed in the CCR/PA, while there had not been any documented releases from the Paint Mix Building and evidence of a release was not observed, these samples were collected to evaluate this AOI as a possible source of the TCL VOCs found in BEC-4B (AOI 3) during Preliminary Groundwater Investigations. Soil samples were collected from a six-inch interval shallow (within 0 to 2 feet) and deep (immediately above the water table) intervals. Each of the soil samples was analyzed for TCL VOCs.

Based on discovery of floating product (lighter-than-water, non-aqueous-phase liquid; LNAPL) in a temporary well point at AOI 6 B-1 (discussed below) in the southwest ^(PN) corner of the Paint Mix Building, additional Geoprobe soil borings (AOI 6 B-3 through AOI 6 B-12) were installed during Stage II of the field investigation to further characterize the extent of the LNAPL and associated soil contamination. Soil samples were collected from the shallow (0 to 2 feet) soil and deep (immediately above the water table) intervals. Additionally, a third soil sample was collected from a six-inch interval in each boring if observations made in the field indicated the potential presence of contamination. At AOI 6 B-10, a fourth sample was also collected in the interval between the shallow sample and the water table based on field conditions. At AOI 6 B-11, the Geoprobe encountered refusal at 8 feet bgs and therefore only the shallow and intermediate sample (no sample was collected immediately above the water table) were collected. All samples were analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals.

An additional boring was advanced at a later date in this area as part of Stage II to collect further information concerning the distribution of the LNAPL and associated soil contamination. This boring (AOI 6 B-13) was installed beneath the floor of the Paint Mix Building. Its location was constrained by accessibility inside the building. Special drilling techniques were employed due to the potentially explosive atmosphere inside the Paint Mix Building. Coring of the floor was conducted using a pneumatic coring machine and water wash to prevent sparking from occurring during coring. A split spoon was advanced using a pneumatic hammer with special tips to prevent sparking. The compressor for the pneumatic equipment was located outside the building. The timing was coordinated with the summer shut down of the Facility to minimize personnel on-Facility during the sampling. Soil samples

were collected from the shallow (0 to 2 feet) soil and deep (immediately above the water table) intervals. One additional soil sample was collected based on field observations made in the field. These samples were also analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals.

To further characterize the soil in AOI 6, six soil borings (AOI 6 B-14 through AOI 6 B-19) were advanced in Stage IIB of the field investigation. Due to utility issues in this area, the top 5 to 10 feet of AOI 6 B-14 and AOI 6 B-15, and the top portion of the boreholes for the well cluster MW-31, 33 and 34 were evacuated with a pneumatic excavation tool to determine the location of subsurface utilities in the vicinity of the borehole. Three additional holes were started this way but were terminated when utilities were encountered. Boreholes AOI 6 B-16 through AOI 6 B-19 were advanced using a hand auger. Soil borings AOI 6 B-15 through B-19 were completed to identify the extent of a sludge-like material found in AOI 6 B-10, and therefore samples were not collected for chemical analysis. The hand-augered holes and AOI 6 B-15 were visually and field observed only (no analytical) to evaluate the extent of a sludge-like material found in AOI 6 B-10. Soil samples were collected from AOI 6 B-14 below the evacuated portion of the hole (5.5 to 6 feet bgs) and the interval above the water table. Soil samples from this boring were analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals.

Borehole Water

Temporary monitoring wells were installed in two soil borings (AOI 6 B-1 (TWP-1) and AOI 6 B-2 (TWP-2)) in the southwest ^(PN) and northeast ^(PN) corners of the Paint Mix Building, respectively. Borehole water samples were collected from each of the temporary well points during Stage I of the RFI/RI field investigation. One-inch diameter PVC screen was placed in the two borings as indicated in the RFI/RI Work Plan. Each groundwater sample was analyzed for TCL VOCs. During collection of the sample from TWP-1, a slight sheen was observed on the water. Based on the analytical results and from this location and the field observations, a monitoring well was installed at this location (see below).

Groundwater

Eleven monitoring wells have been installed and sampled in this AOI: MW-19S, MW-31S, MW-31D and MW-31W, MW-33D and MW-33W, MW-34S, MW-34D and MW-34W, MW-38S, and MW-39S. The "S"-series wells were installed across the water table. The "D" series wells were screened at the bottom of the overburden. The "W" series wells were screened within the weathered bedrock. These wells were installed to evaluate the possible

contribution of the elevated concentrations found in the LNAPL and soil in its vicinity to the groundwater contamination found in BEC-4B (AOI 3). As noted above, in response to the sheen observed in TWP-1, MW-19S was installed in the same location as TWP-1 during Stage I of the RFI/RI field investigation. Following discovery of LNAPL in MW-19S, the remaining wells were installed during Stage II to evaluate the extent of the LNAPL and its effect on groundwater quality in the area around MW-19S.

The MW-31 cluster is located upgradient of MW-19S. The MW-33 cluster is located south^(PN) of MW-19S. The MW-34 cluster is located west^(PN) of MW-19S. And, MW-38S and MW-39S are located downgradient of the MW-33 cluster. The MW-32 cluster was not installed due to access issues (utilities and overhead restrictions).

Groundwater samples were collected from 10 of the 11 wells (water below the LNAPL at MW-19S was sampled and is discussed separately below) during Stage II of the RFI/RI field investigation. All groundwater samples were analyzed for TCL VOCs, TCL SVOCs, and TAL metals. In addition, groundwater samples from the four shallow wells (MW-31S, 34S, 38S, and 39S) were also analyzed for PCBs.

Water Under LNAPL

A sample of water below the LNAPL was collected from MW-19S during Stage I of the RFI/RI field investigation. To collect this sample, a plugged 1-inch, PVC casing was lowered into the water so the plug was in the water near the bottom of the well and below the LNAPL. The plug was removed slowly to allow water from the bottom of the well to enter the casing, while attempting to keep the LNAPL above the inlet to the temporary casing. Samples from inside the temporary casing were collected in a fashion similar to groundwater from the other wells. Following sample collection, the temporary casing was removed.

The sample of water under the LNAPL was analyzed for TCL VOCs, TCL SVOCs, PCB, and TAL metals.

This sample was collected to better characterize constituents associated with the LNAPL, because matrix interference may mask the presence of certain constituents in a pure LNAPL sample. The sample is not considered a normal environmental groundwater sample because it may be contaminated by the presence of LNAPL, which cannot be excluded even using the technique

described above. The data from this sample indicates contamination is present.

LNAPL

A sample of the LNAPL was collected and analyzed for TCL VOCs, TCL SVOCs, PCBs, and TAL metals. In addition, this sample was also fingerprinted (generating an average molecular weight), and analyzed for viscosity. This matrix was analyzed to determine its composition and is not a normal environmental sample. The results of this analysis have not been compared to the screening criteria described in Section 4.0.

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Metals
Soil	22	40	36	35	36
Groundwater	11	10	10	4	10
Borehole Water	2	2			
Water Under NAPL	1	1	1	1	1
LNAPL	1	1	1	1	1

The above sample counts do not include QC samples (e.g. field duplicates).

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred due to past or current operations at the Paint Mix Building. The results of the comparison are summarized in Tables 4.08.1 through 4.08.6 and shown on Figures 16b, 17b, 18a, 18b, 18c, 18d, 19a, 19b, and 19c. These results were used during the RFI/RI field investigation to guide further data collection.

Soil

Table 4.08.1 indicates that concentrations of select certain TCL VOCs, TCL SVOCs, and TAL metals in AOI 6 are higher than the screening criteria discussed in Section 4.01.A and C (based on direct contact and migration to groundwater) at multiple locations in AOI 6. All locations are west^(PN) of the Paint Mix Building. The highest concentrations (up to three orders of magnitude above screening criteria) and the greatest number of constituents that exceed screening criteria are in borings AOI 6 B-10 and AOI 6 B-11 in

the intermediate samples and the samples from immediately above the water table.

The samples collected from AOI 6 B-10 below 8 feet (three six-inch intervals starting at 8.3 feet bgs and ending at 11 feet bgs) encountered a sludge-like material mixed with the soil. This material appears to be red-brown in color and has a consistency similar to putty. It has a strong chemical odor with PID readings as high as 1,655 ppm above background. Although not submitted for chemical analysis below 11 feet, an extension of the boring at AOI 6 B-10 (AOI 6 B-10A) to 25 feet suggests the bottom of this contaminated interval extends to approximately 20 feet bgs (visual and PID readings). The material may not extend fully to that depth, since the fill is noted to end around 18 feet and changes to a glacial till. However, the upper 2 feet of the till appears to be contaminated with constituents from the material, based on the elevated PID readings (above 100 ppm until approximately 20 feet bgs) identified above screening criteria. Other VOCs (2-butanone, 4-methyl-2-pentanone, chlorobenzene, cis-1,2-dichlorobenzene, methylene chloride) were also detected above screening criteria at AOI 6 B-10 in the sample from immediately above the water table. The only exceedances of direct contact screening criteria were at AOI 6 B-10 and B-11. With the exception of AOI 6 B-10 and AOI 6 B-11, the only exceedances of the screening criteria described in Section 4.01.C (based on migration to groundwater) were at AOI 6 B-1 (benzene and xylenes in the sample immediately above the water table) and AOI 6 B-14 (benzene in the intermediate and immediately above water table samples, and xylenes in the sample from immediately above the water table). With the exception of borings AOI 6 B-10 and B-11, the only exceedance of screening criteria is benzo(a)pyrene at AOI 6 B-12, which exceeds direct contact criteria.

TCL VOCs identified above screening criteria are primarily BTEX (benzene, toluene, ethylbenzene, and total xylenes), and TCE. Other VOCs (2-butanone, 4-methyl-2-pentanone, chlorobenzene, cis-1,2-dichlorobenzene, methylene chloride) were also detected above screening criteria at AOI 6 B-10 in the sample from immediately above the water table. The only exceedances of direct contact screening criteria were at AOI 6 B-10 and B-11. With the exception of AOI 6 B-10 and B-11, the only exceedances of migration to groundwater screening criteria were at AOI 6 B-1 (benzene and xylenes in the sample immediately above the water table) and AOI 6 B-14 (benzene in the intermediate and immediately above water table samples, and xylenes in the sample from immediately above the water table).

The TCL SVOCs which exceed the criteria are predominantly PAHs (benzo(a)anthracene, 2-methylnaphthalene, naphthalene, and benzo(a)pyrene) and phthalates (di-n-butylphthalate, and bis(2-ethylhexyl)phthalate). With the exception of borings AOI 6 B-10 and B-11, the only exceedance of screening criteria is benzo(a)pyrene at AOI 6 B-12, which exceeds direct contact criteria. Naphthalene exceeds both the industrial direct contact and migration to groundwater criteria at AOI 6 B-11 (7.5 to 8 feet bgs). 2-methylnaphthalene also exceeds the industrial direct contact criterion in this sample. The concentration of these compounds in the other samples from AOI 6 and the concentration of the other TCL SVOCs in all samples from this AOI are below these screening criteria.

PCB concentrations exceed the screening criteria discussed in Section 4.01A (based on direct contact) at two locations in AOI 6. These locations are AOI 6 B-5 (1.5 to 2 feet bgs) and AOI 6 B-14 (5.5 to 6 feet bgs). PCBs do not exceed any of the other screening criteria discussed in Section 4.01B and C.

Various metals (antimony, arsenic, barium, cadmium, chromium, selenium, and zinc) exceed screening criteria for direct contact and/or migration to groundwater at borings AOI 6 B-10 and B-11 in the intermediate samples and/or samples from immediately above the water table. The direct contact screening criteria are not exceeded, except at AOI 6 B-10 and B-11. The migration to groundwater screening criteria are exceeded for chromium at AOI 6 B-4, B-6, B-7, B-12, and B-14, cadmium at B-6, and manganese at B-7. No samples at AOI 6 had concentrations higher than the screening criteria discussed in Section 4.01.C (based on vapor intrusion).

Overburden Groundwater

As indicated in Table 4.08.2 and on Figures 18a, 18b, and 19a, the overburden groundwater (MW-31S & D, 33D, 34S & D, 38S, and 39S), analytical results indicate a small group of SVOCs exceed the screening criteria discussed in Section 4.02.A (based on drinking water).

Benzo(a)anthracene and benzo(a)pyrene were found in only one of the four shallow water samples (MW-31S) and were not detected in the three deep overburden wells. Neither of these substances have concentrations in excess of the migration to groundwater criteria in the soil samples from AOI 6, including the samples from the MW-31S location.

BCEE exceeded the screening criteria discussed in Section 4.02.A (based on drinking water) in MW-31D and MW-34D at concentrations. BCEE was detected in two of the seven samples of groundwater in AOI 6 (MW-31D and

MW-34D). However, this substance was not detected in any of the soil samples in AOI 6 and was not used at the Facility. According to the Merck Index (11 th Ed), this compound is used as a reagent in organic synthesis (e.g. pharmaceutical manufacturing), not an activity performed on-site.

The VOCs which exceed screening criteria in the overburden groundwater in AOI 6 are primarily benzene and TCE. Benzene exceeds the groundwater screening criterion in MW-33D, MW-34S, MW-38S, and MW-39S. It was detected in 3 of 4 samples in the shallow overburden groundwater and 2 of 3 samples in the deep overburden groundwater. TCE (detected at all 3 deep overburden wells) was above the screening criteria in: MW-31D (upgradient of the other deep wells in this AOI at approximately 230 times the screening criteria), MW-33D and MW-34D but not in the shallow wells in this AOI. In addition, bromodichloromethane and chloroform (MW-34D), 1,2-DCA (MW-31D, MW-33D, and MW-34D), 1,1-DCE and PCE (MW-31D), and vinyl chloride (MW-31D, MW-38S and MW-39S) were detected in excess of screening criteria discussed in Section 4.02.A (based on drinking water).

Manganese was found in all four shallow wells (MW-31S, MW-34S, MW-38S, and MW-39S) in this AOI in excess of the screening criteria during the RFI. Manganese was detected in all three deep overburden wells in this AOI and exceeds the screening criteria in two of the three deep overburden wells (MW-33D and MW-34D). The manganese concentration in these seven wells ranged from 0.009 mg/L (MW-31D) to 30 mg/L (MW-38S). Manganese was detected in all the soil samples from this AOI; however at low concentrations. Only the shallow sample from AOI 6 B-7 (the location for the later installation of MW-39S) exceeds a criterion (migration to groundwater) and the deeper samples from this same location have lower concentrations below the criterion. This suggests the soil at the Facility and the Facility's operations are not a source of the manganese found in the groundwater in this AOI.

No constituent in the shallow or deep overburden in AOI 6 has a concentration that is higher than the criteria discussed in Section 4.01B (vapor intrusion) and 4.01C (construction worker contact).

Weathered Bedrock Groundwater

Weathered bedrock groundwater in this AOI included samples from MW-31W, MW-33W, and MW-34W. Groundwater screening values were exceeded in all three wells for one or more of: VOCs, BCEE, and manganese.

As indicated in Table 4.08.3, manganese exceeded the screening criteria discussed in Section 4.02A (based on drinking water) in MW-31W, MW-33W, and MW-34W. It was detected in 3 of 3 samples at concentrations lower than in the overburden (0.094 mg/L to 1.16 mg/L).

BCEE exceeded the screening criterion in all three weathered bedrock monitoring wells (MW-31W, MW-33W, and MW-34W). As described above, BCEE was not found in soil samples from this AOI and is not expected to be from Facility operations. The concentrations in these wells are similar to the concentrations in the overburden wells. This suggests a potential off-Facility source.

The VOCs that exceed the screening criteria discussed in Section 4.02A (based on drinking water) in the weathered bedrock groundwater in this AOI are: benzene, carbon tetrachloride, chloroform, chlorobenzene, 1,2-DCA, 1,1-DCE, methylene chloride, PCE, TCE, and VC. Benzene was above the screening criteria in: MW-31W (upgradient of the other weathered bedrock wells in this AOI at approximately 300 times the screening criteria), MW-33W, and MW-34W. TCE was above the screening criteria in: MW-31W (650 times the screening criteria), MW-33W (260 times the screening criteria), and MW-34W (also 260 times the screening criteria). Carbon tetrachloride, chloroform, chlorobenzene, 1,2-DCA, 1,1-DCE, methylene chloride, PCE, and vinyl chloride were also detected above the screening criteria in MW-31W (the upgradient weathered bedrock well in this AOI). These were, except for 1,1-DCE, at concentrations higher than in the two downgradient weathered bedrock wells in this AOI. 1,2-DCA, 1,1-DCE, PCE, and vinyl chloride were detected above the screening criteria in MW-33W, and MW-34W also. All the 1,2 DCA concentrations are at least 10 times the screening criteria. 1,1 DCE concentrations were only just above the screening criteria. Chlorobenzene was also detected at concentrations above the screening criteria at MW-33W. The decrease in concentrations from upgradient to downgradient wells across this AOI and the higher concentration in the weathered bedrock compared to the overburden indicates an upgradient source.

At the three locations in AOI 6, where wells are clustered (two or three wells in a cluster: MW-31S, MW-31D & MW-31W; MW-33D & MW-33W; and MW-34S, MW-34D, & MW-34W) the concentration of TCE and other chlorinated volatile organic compounds (CVOs) observed increases from shallow to deeper depths (S is shallowest and W is deepest). For example, at the MW-31 cluster, the TCE concentration increases from 0.0004 mg/L

(below the screening criteria) in the S well to 0.65 mg/L in the W well. Similarly at the MW-33 cluster the TCE concentration increases from 0.016 mg/L in the D well (no S well at this cluster; the nearest S well (MW-39S) does not have detectable concentrations of TCE) to 0.26 mg/L in the W well. Also at the MW-34 cluster, the TCE concentration increases from non-detect in the S well to 0.26 mg/L in the W well.

The types and number of compounds also change from shallow to deep. At the MW-31 cluster, there are no compounds that exceed either the screening criteria in the S well. At the D well, five CVOCs (including TCE and degradation products) exceed criteria. In the W well in this location, the same five compounds were identified, generally at higher concentrations (the exception being 1,1 dichloroethene) plus four additional CVOCs and benzene. At MW-33D, TCE, 1,2 dichloroethane and benzene were detected. At the W well in this cluster, the compounds increased to the same five noted in MW-31D plus chlorobenzene and benzene. At the MW-34 cluster, only benzene exceeds the screening criteria in the S well. In the D well at this location, only TCE exceeds the screening criterion. And, in the W well in this cluster, the same five compounds in MW-31D plus benzene are found above their respective criteria. Many of these VOCs are not known to have been used by the Facility: carbon tetrachloride, chlorobenzene, chloroform, and methylene chloride.

The concentration of TCE in all three strata monitored by these cluster wells decreases from the upgradient (MW-31 cluster) to the downgradient (represented by MW-33 cluster and MW-34 cluster). The LNAPL and water under the LNAPL, discussed below, are between the upgradient and downgradient locations suggesting the contaminants in these matrices are isolated and not contributing to a wide-spread plume in the lower groundwater zones.

The vertical distribution of groundwater contaminants (concentration increasing with depth), the lack of these compounds in the widespread soils in AOI 6 (generally not found above screening criteria except in the immediate vicinity of the LNAPL), and the fact that many of these compounds were not used by the Facility suggest the source of the contamination found in the weathered bedrock in this AOI is upgradient of this AOI and the LNAPL and sludge found in a limited area is not a major contributing source.

Borehole Water

A sample of borehole water collected from each of two temporary well points were analyzed for VOCs. TWP-1 was installed outside the southwest^(PN) corner of the Paint Mix Building. TWP-2 was installed outside the northeast^(PN) corner of the building. These samples are not considered groundwater samples because they were not collected from permanent monitoring wells. The data in this section are compared to the screening criteria but were not considered in evaluating risk of exposure to groundwater and the contaminants in the groundwater. These results were only used to help define the scope of the groundwater investigation in this AOI.

Table 4.08.4 and Figure 18a display the data for these points. Benzene and VC were detected slightly above screening criteria in TWP-1. However, a sheen was observed on the water removed from TWP-1; therefore a permanent monitoring well was installed in this location (MW-19S) at the end of Stage I of the field investigation. None of the concentrations observed in the borehole water exceed the groundwater contact criteria or the industrial groundwater vapor intrusion criteria.

Water Under NAPL

As noted above, a sample from MW-19S was collected by attempting to isolate a sample of water inside a temporary casing extended below the LNAPL and sampling the water inside the temporary casing. TCL VOCs, TCL SVOCs, and TAL metals were identified in this water in excess of groundwater-related screening criteria. Although this sample is not considered representative of groundwater because of the sampling technique may have resulted in inclusion of LNAPL in the sample (see LNAPL quality discussion below), these results are included for completeness. Table 4.08.5 and Figure 18a indicate the data for this point.

LNAPL

Upon discovery of LNAPL in MW-19S, a sample was collected for evaluation. This sample was tested for a fingerprint analysis and viscosity. The viscosity of this material is 39.26 cSt at 60° F. The fingerprint analysis (using gas chromatography with flame ionization and electron capture detectors) revealed: it contains a wide range of petroleum hydrocarbons (ranging from n-C₇ to n-C₂₉) with an average molecular weight of 184 g/mole. The analysis suggests the LNAPL contains compounds typically found in gasoline or coal tar (e.g. BTEX and methylnaphthalene), polycyclic aromatic hydrocarbons, chlorinated organic compounds and PCBs.

A sample of the LNAPL was also collected for chemical analysis. The chemical data is in Table 4.08.6 and shown in Figure 18a. This data was not screened against any particular criteria. The concentrations found in this matrix were used directly in the risk assessment to determine if exposure to the LNAPL would create an unacceptable risk. A wide range of substances was found in this material. The TCL VOCs were: benzene, cumene, cyclohexane, cis-1,2 dichloroethene, ethylbenzene, methylcyclohexane, toluene, trichloroethene, and total xylenes. The TCL SVOCs found were: PAHs, carbazole, and dibenzofuran. The TAL metals detected were: cadmium, chromium, copper, lead, selenium, vanadium and zinc. PCBs were also detected.

A similar set of TCL VOCs were found in both the LNAPL and the soil samples containing the sludge-like material (AOI 6 B-10 between 8 and 11 feet bgs). These two locations (MW-19S containing the LNAPL and AOI 6 B-10) are only a few feet. Because of the proximity and the similarity in the VOC make up of the two matrices, this material may be contributing to the LNAPL.

Investigation of groundwater around the LNAPL, as discussed above, reveals LNAPL is limited to the vicinity of MW-19S (it is not observed, even as a sheen) in any of the surrounding wells. In addition, soil evaluation (chemical and field parameters, suggest the material found in the soil in the vicinity of the LNAPL is limited to an area bounded by the monitoring wells in AOI 6 and the soil sample collected from beneath the Paint Mix Building.

C. Conclusions

The soil data indicate that a potentially significant release of hazardous constituents has occurred at AOI 6. This release is localized to the southwest ^(PN) corner outside the Paint Mix Building. Because the location of the soil contamination outside the southwest ^(PN) corner of the Paint Mix Building is so close to the structure and extends to at least 18 feet bgs, and current Facility personnel have no record of this material being placed, it is unlikely this material was placed after the construction of the Paint Mix Building. An excavation to place this material after the Paint Mix Building was in place would have required structural support of the building. Therefore, this material was likely placed before the mid-1960s when the Paint Mix Building was constructed. Historical aerial photography of the site suggests light surface use of this area prior to construction of the Paint Mix Building. It is possible this material may have been placed in the vacant lot prior to General Motor's acquisition of the property and construction of the Facility in the mid-1930s.

The soil data indicate that TCL VOCs, PAHs and TAL metals are present in the soil in excess of the industrial direct contact and migration to groundwater screening criteria. Isolated findings of PCBs (one near surface soil sample and one soil sample greater than 5 feet bgs) also exceed the screening criteria.

BTEX and halogenated hydrocarbons (e.g., TCE) exceed groundwater screening criteria in the groundwater. The halogenated hydrocarbons are believed to be migrating from an upgradient source not currently identified because: i) the concentrations increase with depth from below screening criteria at the water table to concentrations well above screening criteria in the weathered bedrock, ii) the detection of these substances in soil is isolated to sludge-like material in a location outside the southwest^(PN) corner of the Paint Mix Building, and iii) their concentration decrease from upgradient to downgradient of the sludge. In addition, many of the TCL VOCs and TCL SVOCs found in this AOI primarily in groundwater do not appear to be related to Facility operations (BCEE, carbon tetrachloride, chlorobenzene, chloroform, and methylene chloride). Further field investigations to identify the source of the high VOC concentrations found in the weathered bedrock and deep overburden in AOI 6 will be performed at both on-Facility and off-Facility locations. The results of these investigations will be reported in an addendum to this RFI/RI report.

Manganese in groundwater exceeds the GWQS in 9 of 10 wells in the AOI and exceeds the USEPA screening criterion in 6 of the 10 wells, including all of the shallow wells. However, manganese was detected in all the soil samples at concentrations below migration to groundwater screening criteria, except for one shallow location at which the concentration decreases below it, and therefore the soil is not considered to be a source of the manganese in the wells in this AOI.

LNAPL containing BTEX, TCE, c-1,2 DCE, and PCBs was identified in MW-19S. However, this material has not migrated any measurable distance from MW-19S, likely due to the high viscosity of the LNAPL combined with the low permeability fill (10^{-4} cm/sec).

RFI soil sampling has adequately characterized the vertical and horizontal extent of soil contamination in this AOI to perform a risk assessment of this AOI. Overburden groundwater sampling has also adequately characterized the horizontal extent in this AOI to perform a risk assessment of this AOI. The risk evaluation is presented in Section V. The vertical and horizontal extent of the deeper groundwater contamination is not complete. Additional investigation is planned to fill this data gap. The results of these investigations will be reported in an addendum to this RFI/RI report.

4.09 AOI 7 - Former Bulk Fluids AST Farm

AOI 7 is a former enclosed AST farm comprised of 12 tanks. The area is currently paved. AOI 7 is located west ^(PN) of the main assembly building, and southeast ^(PN) of the Paint Mix Building (AOI 6).

GM personnel indicate that the 12 ASTs consisted of two 50,000-gallon vertical tanks, one 24,000-gallon horizontal tank, and nine 12,000-gallon horizontal tanks. The tanks had been used to store gasoline, diesel, motor oil, transmission fluid, brake fluid, and antifreeze. According to the EPI/PA, the ASTs were installed in the 1960's and removed from service in November 1991. GM placed the replacement tanks (AOI 9) for this storage requirement into service in 1993 following a plant shutdown. The shutdown started in 1991, consistent with the removal-from-service date for these ASTs. The ASTs were dismantled and removed from the Facility in 2000. A review of the historic aerial photographs, however, indicates that ASTs were present in this area beginning in 1940. It is unknown whether the referenced ASTs are original or have been replaced one or more times since the Facility was constructed. Furthermore, it is unknown whether the ASTs were historically used to store products that are different from those described above.

Several unspecified spills have been reported for this area. However, based on a review of the aerial photographs, it does not appear that the ASTs were enclosed since the date of their original construction. The nature of any piping related to the tanks is unknown. GM personnel indicate that during AST removal activities, GM did not observe any indication of soil contamination in this area. However, they did not collect any soil samples in this area during this activity.

No historic use of the area prior to construction of the AST farm was identified in the CCR/PAR. No previous investigations of soil or water quality for this area have been conducted prior to the RFI/RI.

A. Scope and Results

The scope of the RFI/RI field investigations for AOI 7 included the collection of soil and groundwater samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations in this AOI. The RFI/RI sampling locations for soil and groundwater are shown on Figures 16a, 17a, 18a, 18b, and 19a.

The following is a summary of the sampling activities performed for each medium during the RFI/RI at AOI 7:

Soil

During Stage I of the RFI/RI field investigation, three Geoprobe soil borings (AOI 7 B-1 through AOI 7 B-3) were installed to obtain an overall assessment of AOI 7, as proposed in the RFI/RI Work Plan. Soil samples were collected in the shallow (0 to 2 feet) and deep (immediately above the water table) intervals. Soil boring in AOI 7 B-2A was required after collection of the shallow sample in AOI 7 B-2 to move to an adjacent location due to a subsurface obstruction. Each of the samples were analyzed for TCL VOCs and TCL SVOCs.

Based on potentially significant concentrations of PAHs (benzo(a)pyrene) and BTEX detected in these sample locations, additional Geoprobe soil borings (AOI 7 B-4 through AOI 7 B-10) were installed during Stage II of the RFI/RI field investigation to further characterize the extent of these materials in soil. Soil samples were also collected from borings for MW-24S and MW-25S during installation. Soil samples were collected from shallow (0 to 2 feet) and deep (immediately above the water table) intervals. Additionally, a third soil sample was collected from each boring based on field observations. Samples from AOI 7 B-4 through AOI 7 B-10 were analyzed for TCL VOCs and the shallow samples were also analyzed for PAHs. Following review of this data, the elevated TCL VOCs in AOI 7 B-1 appeared to be an isolated finding and the remaining samples (AOI 7 B-11 through AOI 7 B-13) were collected at similar intervals, but analyzed for PAHs only. Note that AOI 7 B-13 was installed inside the building. Also, AOI 7 B-8A was completed adjacent to AOI 7 B-8 to obtain a deeper sample to evaluate the vertical extent of PAHs found at 3.5 to 4 feet in the original sample.

Groundwater

Groundwater samples were collected during the RFI/RI field investigation from the following overburden groundwater monitoring wells: MW-24S and MW-25S. Both of these wells were installed as part of the RFI/RI field investigation. As noted above, soil samples were collected for TCL VOC and PAH analyses during the well installation. Groundwater from these monitoring wells was analyzed for TCL VOCs and TAL metals.

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Metals
Soil	17	32	33	NA	NA
Groundwater	2	2	NA	NA	2

The above sample counts do not include QC samples (e.g. field duplicates).

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Tables 4.09.1 and 4.09.2 and shown on Figures 16a, 17a, 18a, 18b, and 19a. These results were used during the course of the RFI/RI field investigation to guide additional data collection.

Soil

Table 4.09.1 and Figures 16a and 17a indicate that a limited number of TCL VOCs and TCL SVOCs have concentrations in soil at AOI 7 that are higher than the screening criteria discussed in Section 4.01.A (based on direct contact) and 4.01B (based on migration to groundwater)

Toluene and total xylenes are the only TCL VOCs exceeding the direct contact screening criteria, at AOI 7 B-1 in the sample immediately above the water table. Benzene, toluene, ethylbenzene and/or total xylenes exceed the migration to groundwater screening criteria, at AOI 7 B-1 and B-3 in samples at various depths. These exceedances are limited to one sample above Geoprobe refusal (AOI 7 B-1; 6.5 to 7 feet bgs). A subsequent sample from adjacent to this location (AOI 7 B-4) from above the water table (7.5 to 8 feet bgs) indicated the concentrations of these compounds were below the screening criteria. MW-24S was installed in this area, adjacent to AOI 7 B-1. The TCL VOCs exceeding the migration to groundwater criteria are the four BTEX compounds. Ethylbenzene, toluene and xylene exceed their criterion in AOI 7 B-1 at geoprobe refusal. As noted above, the concentration of these substance in soil in this vicinity decrease below the migration to groundwater screening criteria at the water table. Benzene also exceeds its criterion over a four foot interval above the water table in AOI 7 B-3.

TCL SVOCs exceeding the screening criteria discussed in Section 4.01.A (based on direct contact), similarly exceeding the criteria are: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene,

benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and naphthalene (all PAHs). All compounds exceeding these criteria occur in AOI 7 B-8 at 3.5 to 4 feet bgs. The only TCL SVOCs exceeding the screening criteria discussed in Section 4.01.B (based on migration to groundwater) criterion is PAHs (acenaphthene, fluoranthene, fluorene, naphthalene, and pyrene) in an intermediate depth (3.5 to 4 feet bgs) at AOI 7 B-8. A deeper sample above water table (AOI 7 B-8A; 8.5 to 9 feet bgs) has a lower concentration below this criterion. These values, again, are only at AOI 7 B-8 at the mid level (3.5 to 4 feet bgs) and these substances are below their respective criterion in the deeper sample at AOI 7 B-8A (8.5 to 9 feet bgs).

Groundwater

Table 4.09.2 and Figures 18a, 18b, and 19a indicate manganese and arsenic are the only TAL metals that have a concentration in overburden groundwater (MW-25S) that is higher than the screening criteria discussed in Section 4.02.A (based on drinking water).

In addition, benzene and tetrachloroethylene are the only TCL VOCs that have a concentration in shallow overburden groundwater (MW-24S) that is higher than the screening criteria discussed in Section 4.02.A (based on drinking water).

No constituent has a concentration in shallow overburden groundwater in AOI 7 that is higher than the criteria discussed in Sections 4.01B (based on vapor intrusion) and 4.01C (based on construction worker contact).

C. Conclusions

The soil data collected during several phases of RFI/RI field investigations in AOI-7 indicate that a potentially significant release of hazardous constituents has occurred within AOI 7. BTEX and PAHs are present in the sub-surface and deep (above water table) soil in excess of the screening criteria and also the migration to groundwater criteria.

Shallow overburden groundwater data at MW-24S and MW-25S indicate that the concentration of arsenic and manganese exceeds the screening criteria described in Section 4.02.A (based on drinking water). In addition, TCL VOCs (benzene and PCE) exceed exceeds the screening criteria described in Section 4.02.A (based on drinking water) in MW-24S. This well is installed in the immediate vicinity of AOI 7 B-1. The benzene in the groundwater at MW-24S is consistent with the benzene found in the subsurface soil in this location; however, the soil does not have a detectable concentration of benzene immediately above the water table. The

concentration of these substances in the well downgradient of MW-24S, MW-25S is below the screening criteria based.

As presented in Figures 16a and 17a, RFI/RI soil sampling has adequately characterized the vertical and horizontal extent of soil contamination in this AOI to perform a risk assessment of this AOI. Overburden groundwater sampling has also adequately characterized the horizontal extent in this AOI to perform a risk assessment of this AOI. The risk evaluation is presented in Section V.

4.10 AOI 8 – Former Powerhouse Heating Oil ASTs

AOI 8 includes three former 100,000-gallon ASTs which contained No. 6 fuel oil and the associated piping to the former Power House. The AOI is located on the west ^(PN) side of the Facility located between the water tank and AOI 7. According to Facility personnel, small quantities of No. 2 fuel oil were also used in the Power House and may have been stored in this AOI or AOI 7. Based on a review of aerial photographs, the tanks were erected between 1944 and 1951 based on aerial photography. The 1951 aerial photograph, and subsequent photos up to and including 1993, show these ASTs with what appears to be secondary containment berms.

The former ASTs were operational from the early 1940's, to the closure of the ASTs in June of 1999. The ASTs have reportedly contained only fuel oil products. Reviewed records do not indicate releases had occurred in this area. Facility employees familiar with the AST removal activity noted stained soil in this area during AST removal activities.

A. Scope and Results

The scope of the RFI/RI field investigations at AOI 8 included the collection of soil samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the operations of the former fuel oil storage tanks. The RFI/RI sampling locations for soil are shown on Figures 16a and 17a. The following is a summary of the sampling activities performed during the RFI/RI at AOI 8.

During Stage I of the RFI/RI field investigations, three Geoprobe soil borings (AOI 8 B-1 through AOI 8 B-3) were installed at AOI 8 to provide even coverage of the area, as proposed in the RFI/RI Work Plan. Soil samples were collected from the shallow (0 to 2 feet) and deep (immediately above the water table) intervals in accordance with the RFI/RI Work Plan. Samples were analyzed for TCL VOCs and TCL SVOCs.

Based on potentially significant concentrations of certain PAHs (benzo(a)pyrene) detected in the shallow sample at boring AOI 8 B-2 and AOI 8 B-3, additional soil

boring locations (AOI 8 B-4 through AOI 8 B-8) were installed during Stage II of the field investigation to further characterize the PAHs in shallow soil. Soil samples were collected from the shallow (0 to 2 feet) and deep (immediately above the water table) intervals. All samples from borings AOI 8 B-4 through AOI 8 B-8 were analyzed for PAHs. Following review of the data from these five locations, four additional soil borings (AOI 8 B-9 through AOI 8 B-12) were installed during subsequent efforts in Stage II. Soil samples were collected from the shallow (0 to 2 feet) and deep (immediately above the water table) intervals. These samples were also analyzed for PAHs.

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Metals
Soil	12	6	24	NA	NA

The above sample counts do not include QC samples (e.g. field duplicates).

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.10.1 and shown on Figures 16a and 17a. These results were used during the RFI/RI field investigation to guide further data acquisition.

Table 4.10.1 and Figures 16a and 17a indicate that certain PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) exceed the screening criteria discussed in Section 4.01A (based on direct contact). These concentrations are distributed in the soil in the top two feet at the southern end of AOI 8: AOI 8 B-2, AOI 8 B-3, AOI 8 B-4, AOI 8 B-5, AOI 8 B-7, AOI 8 B-8 and AOI 8 B-9. Benzo(a)pyrene also exceeds this screening criterion at 7 to 7.5 feet bgs at AOI 8 B-6. None of the constituents exceed the migration to groundwater criteria.

All other TCL SVOCs tested for were either below detection values or soil screening criteria. All TCL VOC sample analyses were below detection values or soil screening criteria. No soil samples at AOI 8 had concentrations higher than the screening criteria discussed in Section 4.01B (based on vapor intrusion).

C. Conclusions

The soil data collected during several events of RFI/RI field investigation in AOI-8 indicate that a potentially significant concentration of certain PAHs are present in

surface soil in the southern half of AOI 8. Only at one location, near the southwest corner ^(PN) of the AOI does benzo(a)pyrene concentration exceed the screening criteria above water table, but this concentration does not exceed the migration to groundwater criterion. None of the concentrations exceed 10 times the criterion.

As presented in Figures 16a and 17a, RFI/RI soil sampling has adequately characterized the vertical and horizontal extent of soil contamination in this AOI to perform a risk assessment of this AOI. The risk evaluation is presented in Section V.

4.11 AOI 10 - Former Storage Shed

AOI 10 consists of a former storage shed, which was reported by a Facility employee to have had a dirt floor and was suggested to have been used for the storage of unspecified hazardous materials. This shed may be the same building identified in the Sanborn maps from 1950 and 1951. The shed, according to the Sanborn Maps, was located in the northeastern ^(PN) portion of the property west ^(PN) of the original portion of the Anchor Motor Freight building. This building did not appear in the 1940 or has been razed (it did not appear in the 1951 aerial photographs nor the 1958 Sanborn Map), and the western ^(PN) extension of the Anchor Motor Freight building appears to have been built atop of it between 1951 and 1958 (based on aerial photographs).

A. Scope and Results

The scope of the RFI/RI field investigations at AOI 10 involved the collection of soil samples to determine whether a potentially significant release of hazardous constituents has occurred as the result of former operations at this former storage shed. The RFI sampling locations for soil are shown on Figures 16c and 17c.

The following is a summary of the sampling activities performed for the evaluation of the soil during the RFI/RI at AOI 10.

During Stage I of the RFI/RI field investigation, three soil borings (AOI 10 B-1 through AOI 10 B-3) were completed to provide even coverage of the area, as proposed in the RFI/RI Work Plan. Soil samples were collected from the shallow (0 to 2 feet) and deep (immediately above the water table) intervals. Each sample was analyzed for TCL VOCs, TCL SVOCs, TAL metals and PCBs.

Based on potentially significant concentrations of certain PAHs (benzo(a)pyrene) in the shallow sample at boring AOI 10 B-1 and certain TAL metals (arsenic, beryllium and lead) in the surface sample at boring AOI 10 B-3, additional soil borings (AOI 10 B-4 through AOI 10 B-9) were completed during Stage II of the field investigation to

further characterize the extent of contamination in the shallow soil. Soil samples were collected from the shallow (0 to 2 feet) interval at all borings. Samples were collected from the deep interval (above the water table) from borings AOI 10 B-4, B-5, B-6, and B-7. Additionally, a third soil sample was collected from an intermediate depth (approximately five feet bgs) from borings AOI 10 B-4, B-5, B-6, and B-7. AOI 10 B-4 through B-6 were used to provide further information on the elevated TAL metals in AOI 10 B-3, and, therefore, the samples from these borings were analyzed for TAL metals. AOI 10 B-7 through B-9 were used to provide further information on the elevated benzo(a)pyrene in AOI 10 B-1, and, therefore, the samples from these borings were analyzed for PAHs. In addition, the samples from AOI 10 B-6 were also analyzed for TCL VOCs because of the sample locations proximity to a suspected abandoned UST (see AOI 26 below).

With a few exceptions (e.g. AOI 10 B-10 identified black sand without elevated lead), the elevated lead concentrations are generally associated with the black sand fill. Based on potentially significant concentrations of certain PAHs (benzo(a)pyrene) in the surface sample at boring AOI 10 B-7 and certain TAL metals (arsenic, beryllium, copper, lead, and zinc) in the surface sample at borings AOI 10 B-5, B-6 and B-7, additional soil borings (AOI 10 B-10 through AOI 10 B-19) were installed during a later portion of the Stage II field investigation. Samples were collected from the shallow (0 to 2 feet) and deep (immediately above the water table) intervals at all of the borings. A soil sample from an intermediate depth (approximately four feet bgs) was obtained from borings B-11, B-12, B-14 and B-18. Samples from AOI 10 B-10 through B-14, B-16, and B-18 were analyzed for PAHs and arsenic, beryllium, copper, lead, and zinc. Samples from AOI 10 B-15 and B-17 were analyzed for arsenic, beryllium, copper, lead, and zinc only, and samples from AOI 10 B-19 were analyzed for TAL-metals.

Based on potentially significant concentrations of lead in the shallow soil and correlation of these elevated concentrations to a black fill material in AOI 10 and AOI 11 (discussed below), additional soil borings (AOI 10 B-20 through AOI 10 B-23) were hand augured during a later portion of Stage II field investigation. A sample from a six-inch interval representing the shallow (0 to 2 feet) and from 3.5 to 4 feet bgs were collected from all four locations. A third sample from the black fill in AOI 10 B-23 at 1.5 to 2 feet bgs was also collected. During this field event, all samples were analyzed only for lead.

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Metals
Soil	23	9	29	6	48

The above sample counts do not include QC samples (e.g. field duplicates).

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at AOI 10. The results of the comparison are summarized in Table 4.11.1 and shown on Figures 16c and 17c. These results were used during the RFI/RI field investigation to guide additional data collection efforts.

Soil

Table 4.11.1 and Figures 16c and 17c indicate that certain metals (arsenic, beryllium, copper, lead, and zinc), and benzo(a)pyrene have concentrations in surface soil at AOI 10 that are higher than the screening criteria discussed in Section 4.01A (based on direct contact). The benzo(a)pyrene is limited to the southern ^(PN) portion of this AOI: AOI 10 B-1, AOI 10 B-7, AOI 10 B-10 and AOI 10 B-18. The benzo(a)pyrene detections, which extend to the fence line, have been adequately characterized for risk evaluation purposes. Arsenic is limited to the surface soil immediately east ^(PN) of the Anchor Motor freight building (AOI 10 B-3, AOI 10 B-4, AOI 10 B-5 and AOI 10 B-6) and two isolated locations: (AOI 10 B-18 and AOI 10 B-19) that are separated from the other arsenic by soil with lower concentrations of arsenic.

Lead concentrations are generally associated with the black sand fill in AOI 10 which has been found in numerous borings in . The shallow soil (0 to 2 feet bgs): AOI 10 B-3 through AOI 10 B-6, AOI 10 B-12, AOI 10 B-13, AOI 10 B-18, AOI 10 B-19, AOI 10 B-21, and AOI 10 B-23 in excess of the screening criterion discussed in Section 4.0A (based on direct contact). Stratigraphic descriptions of the material removed during the sampling activities in this AOI indicate a black sand with other fill-like materials (clinkers, ash, debris) exist over a wide area of this AOI, generally in the upper two to three feet. Samples from other AOIs along the eastern ^(PN) portion of the Facility (AOI 10, AOI 11, AOI 26) suggest this material extends over a wide area of this part of the Facility. Although exceptions exist (e.g. AOI 10 B-10), where this black fill is found that do not have elevated lead concentrations, in general, black fill was associated with elevated lead concentrations. Based on the lead concentrations, the nature and

extent has been adequately characterized for risk evaluation purposes, and the concentrations dramatically reduce towards the eastern^(PN) property boundary.

As discussed in Section 3.06, portions of the fill were placed in this eastern^(PN) area of the Facility prior to construction of the facility (1936). The source and date of placement of this fill is unknown. It appears to have been some time between 1935 and continued until sometime after 1961. The 1940 aerial photograph reviewed for the Facility shows the northern^(PN) portion of this area already in use as a finished vehicle storage area and the Anchor Motor Freight building is present. The area east^(PN) of the main assembly plant (as it existed in 1940), south^(PN) of the area being used by Anchor Motor Freight in 1940, north^(PN) of the then Gordon's Gin Distillery and west^(PN) of the property line appears to be lower than the surrounding lands in 1940 and was still being filled in 1951. All but a small area northeast^(PN) of the Gordon's tankage is paved in 1958 and 1961. The entire area is paved in 1968.

TAL metal concentrations in six (AOI 10 B-3, AOI 10 B-4, AOI 10 B-5, AOI 10 B-6, AOI 10 B-18, and AOI 10 B-19) of the sample locations in AOI 10 exceed the migration to groundwater criteria in the surface soil. The TAL metals in each location are varied, but include: antimony, arsenic, barium, chromium, copper, manganese, nickel, and silver. The concentration of these metals in deeper samples at the same locations decrease to below the screening criteria.

Laboratory analytical data summarized on Table 4.11.1 indicated detections of TCL VOC constituents and PCBs at concentrations below their respective comparison criteria.

C. Conclusions

The soil data collected during several field events performed during the RFI/RI investigation in AOI 10 indicates that potentially significant concentrations of certain metals (arsenic and lead) and benzo(a)pyrene are present in surface soil above direct contact screening criteria within AOI 10. Concentrations of various metals are also observed in the surface soil in excess of the migration to groundwater criteria; however, the concentrations decrease with depth to below the applicable criterion before reaching the water table.

Although none of the Facility's monitoring wells are associated with AOI 10, a few of the wells installed prior to the RFI/RI, overlap with many of the Stage II AOI 10 soil samples, as shown on Figure 19a. A review of the analytical results from the shallow wells in this overlap area (BEC-12S through BEC-13S) indicate lead has not

impacted groundwater in excess of the screening criteria. However, the lead concentration in BEC-10S, on the upgradient side of the soil sampling area, does exceed the screening criteria. Groundwater data for these wells are discussed section below. Further, the fact that the area is paved, with limited surface recharge, coupled with the decrease in metals concentrations in the deeper soil samples, indicates that groundwater would not likely be impacted by the elevated metal concentrations from the shallow soil.

As presented in Figures 16c and 17c, RFI/RI soil sampling has adequately characterized the vertical and horizontal extent of soil contamination in AOI 10 for risk evaluation purposes. The risk evaluation is presented in Section V.

4.12 AOI 11 – Former Reclamation Area

AOI 11 consists of a paved, former outdoor reclamation storage area for materials including: scrap metal, paint, and thinners awaiting recycling. Based on a review of available files, interviews with Facility personnel, and a review of historical aerial photographs, this area was approximately 75-ft by 75-ft. The area was not present on the 1958 aerial photograph, but present on the 1961 photo, hence appears to have been active since the early 1960's. This AOI was observed in the 1993 photograph. However the area was not active in the 2002 during the Facility visits for the RFI/RI. The reported location is at the northeast ^(PN) corner of the Incinerator Building. The reclamation area is no longer active and the area is currently paved. Reviewed records did not indicate releases occurred in this area as detailed in the CCR/PAR.

A. Scope and Results

The scope of the RFI/RI field investigations at AOI 11 involved the collection of soil and groundwater samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of historic operations in this area. The RFI sampling locations for soil and groundwater are shown on 16d, 17d, 18a, 18b, 18c, 18d, 19a, 19b, and 19c.

The following is a summary of the sampling activities conducted for each medium during the Preliminary Groundwater Investigation and RFI/RI at AOI 11:

Soil

Monitoring well cluster 16, including MW-16S (overburden), MW-16W (weathered bedrock), and MW-16B (bedrock), was completed in July and August 2002 as part of the Preliminary Groundwater Investigation. Shallow soil samples were submitted for TCL VOC analysis. The location of this well cluster is adjacent to the AOI 11 investigation area.

Three soil borings (AOI 11 B-1 through AOI 11 B-3) were completed on January 6, 2003, during the initial stage of the field investigation for the RFI/RI. Soil samples were collected shallow (0 to 2 feet) and deep (immediately above the water table) and analyzed for TCL VOCs, TCL SVOCs, and TAL metals. An intermediate soil sample was collected from AOI 11 B-3 and analyzed for TCL VOCs, TCL SVOCs, and TAL metals.

To further evaluate the elevated TCL SVOCs and TAL metals, four additional soil borings (AOI 11 B-4 through AOI 11 B-7) were completed on July 25 and 28, 2003 during the second stage of the field investigation. Soil samples were collected shallow (0 to 2 feet), intermediate (approximately 4 to 6 feet) and deep (immediately above the water table). The samples were analyzed for TCL SVOCs and TAL metals.

To further evaluate the elevated TCL SVOCs and TAL metals, thirteen soil borings (AOI 11 B-8 through AOI 11 B-19, and AOI 11 B-13A) were completed from November 10 through 13, 2003, and on November 19, 2003. Soil samples were collected shallow (0 to 2 feet) and deep (immediately above the water table) in borings AOI 11 B-8 through AOI 11 B-19. A third sample was collected at approximately 5 feet from borings AOI 11 B-8 through AOI 11 B-13, AOI 11 B-15 and AOI 11 B-18 based on field observations of fill. Only one sample was collected from boring AOI 11 B-13A at a depth of approximately 5 feet to evaluate the elevated metal concentrations with depth. The samples were analyzed for TCL SVOCs and TAL metals. However, only arsenic, copper, lead and zinc were analyzed at borings AOI 11 B-8, AOI 11 B-9, AOI 11 B-12 through AOI 11 B-19.

To further evaluate the elevated TCL SVOCs and TAL metals, seven additional soil borings (AOI 11 B-20 through AOI 11 B-26) were completed on March 29, 2004. Soil samples were collected from the six-inch interval immediately beneath a black fill observed at all borings. Additionally, a shallow sample (0 to 2 feet) was collected from borings AOI 11 B-20, AOI 11 B-21 and AOI 11 B-26. A third sample was collected from the interval with the highest PID reading from borings AOI 11 B-22 through AOI 11 B-25. A deep sample (immediately above the water table) was collected from boring AOI 11 B-21. All of the samples were analyzed for TAL metals, with the exception of only arsenic, copper, lead and zinc in AOI 11 B-24, lead in AOI 11 B-22 and AOI 11 B-23; and aluminum, cadmium, iron, magnesium, potassium, sodium and calcium at borings AOI 11 B-20 and AOI 11 B-21.

Soil samples from borings AOI 11 B-22 through AOI 11 B-26 were also analyzed for TCL SVOCs.

Groundwater

During the Preliminary Groundwater Investigation, overburden groundwater samples were collected from monitoring wells MW-16S on August 21, 2003 for TCL VOCs.

Overburden groundwater samples were collected for the RFI/RI from monitoring wells MW-16S on January 28, 2003 for TCL VOCs, TCL SVOCs, TAL metals, and PCBs. Overburden groundwater samples were also collected on October 23, 2003 and analyzed for TCL VOCs and TAL metals. Weathered bedrock and bedrock groundwater samples are discussed in Section 4.27.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	27	19	65	NA	668
Groundwater	1	2	1	1	2

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.12.1 to 4.12.3. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred in this area. The results of the comparison are summarized in Tables 4.12.1 to 4.12.3 and shown on Figures 16d, 17d, 18a, 18b, and 19a. These results were used during the RFI/RI field investigation to guide data collection.

Soil

Table 4.12.1 and Figures 16d and 17d indicate that all of the samples collected and analyzed for TCL VOCs in AOI 11 were below the screening

criteria discussed in Section 4.01.A, B, and C (based on direct contact, vapor intrusion, and migration to groundwater).

Table 4.12.1 and Figures 16d and 17d also indicate that certain PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected at concentrations that are higher than the screening criteria discussed in Section 4.01.A (based on direct contact), but below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and migration to groundwater). PAHs were identified in all of the depth intervals, however the shallow interval contained the majority of the exceedances. Several iterations of field activities were utilized to adequately define the detections of PAHs in this area, which identified a black granular fill material in the shallow interval as well. Review of historic aerial photographs and Facility information does not indicate a source of this material. The elevated detections of PAHs were generally, but not always, associated with this fill material. The concentrations of PAHs decrease significantly to the eastern^(PN) property boundary. The data indicate that the nature and extent of the PAHs have been adequately characterized for risk evaluation purposes.

Also as indicated on Table 4.12.1 and Figures 16d and 17d, several TAL metals (including arsenic, copper, lead, and zinc) had concentrations higher than the screening criteria discussed in Section 4.01.A (based on direct contact) at several locations in AOI 11. In addition, several TAL metals (including antimony, arsenic, barium, cadmium, chromium (total), copper, manganese (one location), and zinc (one location)) had concentrations higher than the screening criteria discussed in Section 4.01.C (based on migration to groundwater) at several locations in AOI 11. No TAL metal concentrations were identified above the screening criteria discussed in Section 4.01.B (based on vapor intrusion). The elevated TAL metal detections were only associated with the shallow and intermediate soil samples. Similar to the PAHs discussed above, these elevated detections were generally, but not always, associated with the black granular fill material and appeared to be randomly scattered in the southeastern^(PN) paved area. The nature and extent of the elevated metals appears to be identified through the multiple iterations of field activities for the RFI/RI for risk evaluation purposes. Although elevated lead concentrations are present at AOI 11 B-22 on the eastern^(PN) property boundary, the concentrations are several orders of magnitude lower than others detected to the west^(PN).

Groundwater

Tables 4.12.2 and 4.12.3, and Figures 18a, 18b, and 19a indicate that all of the samples collected and analyzed for TCL VOCs and TCL SVOCs at MW-16S in AOI 11 were below the screening criteria discussed in Sections 4.02.A, B, and C (based on drinking water, vapor intrusion, and construction worker contact).

Table 4.12.2 and 4.12.3 and Figures 18a, 18b, and 19a also indicate that certain TAL metals (arsenic and manganese) were detected from the January and October 2003 sampling event, at concentrations above the screening criteria discussed in Section 4.02.A (based on drinking water), but below the screening criteria discussed in Section 4.02.B and C (based on vapor intrusion and construction worker contact).

C. Conclusions

The soil data collected during several phases of RFI/RI field investigations at AOI 11 indicate that potentially significant concentrations of certain PAHs are present in the soil. The soil data also indicate that several TAL metals (including antimony, arsenic, barium, cadmium, chromium (total), copper, manganese, and zinc) are also present in soil at concentrations that could adversely affect groundwater quality and/or are an issue relating to direct contact. Based on the information gathered to date, as discussed in Section 4.11, the elevated PAHs and TAL metals are generally associated with shallow soils where a black granular fill was identified. The distribution of the exceedances is relatively random, but covers a large area on the southeast^(PN) side of the Facility, and extends to the property boundary. However, the concentrations are significantly lower at the property than to the west^(PN). As discussed in Section 4.11, the fact that the area is paved, with limited surface recharge, coupled with the decrease in metals concentrations in the deeper soil samples, indicates that groundwater would not likely be impacted by the elevated metal concentrations from the shallow soil. Therefore, based on the data gathered to for the RFI/RI, the nature and extent has been adequately defined for risk evaluation purposes, presented in Section V.

Overburden groundwater data indicated arsenic and manganese above the screening criteria discussed in Section 4.02.A (based on drinking water). These are similar to Facility-wide detections and do not appear to be an AOI specific issue and may not be related to Facility issues. The data is further evaluated in Section 4.27 and risk evaluation presented in Section V.

4.13 AOI 12 – Historic Process Sewers Lines

Six process/sanitary sewer lines are present at the Facility. Five of these sewers were constructed at the time concurrent with the initial plant construction of the plant (1936), and discharge to a central sewer in the southern ^(PN) portion of the Facility. Untreated process wastewater was conveyed via the five sewers discharging to West Edgar Avenue before 1984. Subsequent to this date, only sanitary sewerage has flowed through these lines. No documentation regarding constituents of the waste streams were identified in the CCR/PAR. One of the six sewers is new and was added to the Facility's sewer system during construction of the WWTP (AOI 13). This new line conveys sanitary sewerage from the WWTP building and pre-treated process wastewater to the municipal sanitary sewer in Pleasant Street. The existing sewer lines are still in place and convey only sanitary sewerage and pre-treated process wastewater in accordance with approval from the Linden-Roselle Sewerage Authority (LRSA).

GM historical documents report that one or more of these sewer lines had broken as a result of settlement of the building. The historical documents also indicate the breaks were subsequently repaired. It was reported that the sewers had local breaks that completely stopped flow within the sewer lines, resulting in replacement of portions of the lines. No previous investigations of soil or water quality for this area have been conducted prior to the RFI/RI.

As described in Section 7.9.2 of the RFI/RI Work Plan, no soil or groundwater samples will be collected for AOI 12. Rather AOI 12 will be evaluated as part of the Facility-wide groundwater investigation, detailed in Sections 4.25 and 4.27.

4.14 AOI 16 – Former Petroleum USTs

AOI 16 comprises eight former USTs that were installed by Anchor Motor Freight, Inc. and used to store fuel oil and other petroleum based fluids. Anchor Motor Freight, Inc. leased the property from GM during the time of installation, operation, and removal of the USTs. GM personnel indicated that the UST farm had not been used since 1979 and that the USTs were removed in March of 1989. Impacts to soil and groundwater were addressed during the excavation to remove the USTs. The tanks have received closure from NJDEP for the petroleum products formerly stored in these USTs. However, previous investigations have indicated the presence of chlorinated TCL VOCs in this area, which required further evaluation in the RFI/RI.

A. Scope and Results

One soil boring, SB-25, was completed during the Preliminary Groundwater Investigation adjacent to this area to evaluate potential soil sources of chlorinated TCL VOCs in this area. Soil samples were collected from shallow (0 to 2 feet) interval,

intermediate (approximately five feet bgs), and deep (above the water table) intervals from SB-25. The soil samples were analyzed for TCL VOCs only.

As identified in the RFI/RI Work Plan, the scope of work for AOI 16 included two rounds (January 2003 and October 2003) of groundwater sampling, obtained from the wells surrounding the former tank area. Overburden groundwater samples were obtained from monitoring wells BEC-2S, BEC-5S (January 2003 only), BEC-7S, BEC-8S, BEC-9S, BEC-10S, BEC-11S, BEC-12S and BEC-1SR (January 2003 only) for TCL VOCs, TCL SVOCs (January 2003 only), TAL metals, and PCBs (January 2003 only). In addition, groundwater samples were collected from the deep overburden/weathered bedrock wells BEC-1D, BEC-2D, BEC-3D, BEC-4D, and MW-1D for TCL VOCs, TCL SVOCs (January 2003 only), TAL metals, and PCBs (January 2003 only). As identified in the RFI/RI Work Plan no additional soil samples were required, based on the results of the groundwater sampling.

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Inorganics
Soil	1	3	NA	NA	NA
Groundwater	14	28	17	17	28

The above sample counts do not include QC samples (e.g. field duplicates).

The groundwater monitoring well locations and results are shown on Figures 18a, 18b, and 19a and summarized in Tables 4.14.1 to 4.14.4. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred in this area. The results of the comparison are summarized in Table 4.13.1 and shown on Figures 18a, 18b, and 19a. These results were used during the RFI/RI field investigation to guide data collection.

Soil

Table 4.14.1 and Figure 16e indicate that several TCL VOCs were detected in Preliminary Groundwater Investigation boring SB-25, but all below the screening criteria described in Section 4.02.A, B, and C (based on direct

contact, vapor intrusion, and migration to groundwater). Further investigation of the soil does not appear warranted.

Overburden Groundwater

Table 4.14.2 and Figure 19a indicates that several TAL metals (arsenic, barium, cadmium, lead, and manganese) were detected at concentrations higher than the screening criteria described in Section 4.02.A (based on drinking water) for selected wells from one or both events. The results do not appear to have a distribution pattern around the AOI. Based on the associated hazardous constituents from this AOI, many of the metals (arsenic, barium, cadmium, and manganese) are not anticipated. Lead, which may have been associated with the AOI activities, was detected in two monitoring wells (BEC-2S and BEC-10S) during the January 2003 sampling event above the screening criteria described in Section 4.02.A (based on drinking water). However, the results were below the screening criteria during the October 2003 sampling event.

Table 4.14.2 and Figures 18a and 18b also indicate that overburden groundwater obtained from monitoring well BEC-9S had concentrations of trichloroethene above the screening criteria described in Section 4.02.A (based on drinking water) for January and October 2003 sampling events. However, upgradient monitoring well BEC-14S (Table 4.14.3), and several upgradient deep overburden/weathered bedrock and bedrock wells also have detections of trichloroethene at higher concentrations for January and October 2003 sampling events, as detailed below and in Section 4.27. This suggests that the source of the trichloroethene may not be related to this AOI.

No overburden groundwater samples from AOI 16 had concentrations higher than the screening criteria described in Sections 4.02.B and C (based on vapor intrusion and construction worker contact) for January and October 2003 sampling events.

Deep Overburden/Weathered Bedrock Groundwater

Table 4.14.4 and Figures 18a and 18b indicate that several TCL VOCs (including trichloroethene, tetrachloroethene, and 1,2-dichloroethane) were detected from deep overburden/weathered bedrock wells BEC-1D, BEC-2D, BEC-3D, BEC-4D and MW-1D in the vicinity of the area, during either or both the January and October 2003 sampling events at concentrations higher than the screening criteria described in Section 4.02.A (based on drinking water).

Table 4.14.4 and Figures 18a, 18b, and 19a also indicate that TCL SVOC (bis(2-chloroethyl)ether) was detected at BEC-1D, BEC-2D, and at concentrations higher than the screening criteria described in Section 4.02.A (based on drinking water). Manganese was also detected at BEC-1D, BEC-2D, BEC-3D, and BEC-4D at concentrations higher than the screening criteria described in Section 4.02.A (based on drinking water).

As indicated Table 4.14.4 and Figures 18a, 18b, and 19a, PCBs were not detected in any of the groundwater samples collected during the sampling events.

No deep overburden/weathered bedrock groundwater samples from AOI 16 had concentrations higher than the screening criteria described in Sections 4.02.B and C (based on vapor intrusion and construction worker contact) for January and October 2003 sampling events.

C. Conclusions

Several TCL VOCs were detected in Preliminary Groundwater Investigation boring SB-25, but all below the screening criteria described in Section 4.02.A, B, and C (based on direct contact, vapor intrusion, and migration to groundwater). Further investigation of the soil does not appear warranted.

Overburden groundwater data collected from shallow wells in AOI 16 for the RFI/RI indicate several TCL VOCs and TAL metals were higher than the screening criteria described in Section 4.02.A (based on drinking water). However, with the exception of lead, these detections do not appear to be associated with historical activities in this AOI and are detected in upgradient, side-gradient, and deeper monitoring wells (deep overburden/weathered bedrock). This information suggests that the exceedances of the screening criteria described in Section 4.02.A (based on drinking water) may be an upgradient or off-Facility issue, which is discussed in Sections 4.25 and 4.27 below and do not require further delineation for this AOI. Additional groundwater delineation is proposed. Regardless, the exceedances are further evaluated in the risk evaluation presented in Section V.

4.15 AOI 17 – Company Car Fuel Fill Point

The company car fuel fill point is located adjacent to and east ^(PN) of the company car garage, between the Administration and Main Assembly Buildings. This area is not currently active. The fill pipe led from this location to the existing bulk tank farm (AOI 9). The exact location of the piping and the timeframe in which the fill port was used is currently not known. A review of Facility files indicated that a release of approximately 25 gallons of gasoline

occurred in this AOI in 1991. The file indicates that the release was contained and removed. Based on available information no additional sampling was done in this AOI to characterize this potential release. Although this area currently is paved, no information was identified to determine the pavement status of this area at the time of the 1991 release.

A. Scope and Results

The scope of the RFI/RI field investigations for AOI 17 involved collection of soil sampling at two locations (AOI 17 B-1 and AOI 17 B-2) for TCL VOCs and TAL metals. These borings were completed on January 3 and January 6, 2003 during the initial stage of the field investigations. Soil samples were collected from the shallow (0 to 2 feet) interval due to the suspected location of the release and proximity of underground utilities. No overburden groundwater samples were collected, due to the absence of constituents of concern in soil.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	2	2	NA	NA	2

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil is shown in Table 4.15.1. In this tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at this AOI. The results of the comparison are summarized in Table 4.15.1 and shown on Figures 16d and 17d. These results were used during the RFI/RI field investigation to guide data collection.

The soil data indicated that there were no detections of TCL VOCs in any of the soil samples submitted for AOI 17. The only TAL metal that was detected was lead, which ranged from 27 mg/Kg to 133 mg/Kg in both borings. The lead concentrations, as well as the TCL VOCs and TAL metals, were lower than the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater) at AOI 17.

C. Conclusions

The RFI/RI soil data collected at AOI 17 indicate that a potentially significant release of hazardous constituents has not occurred. Additional investigation and evaluation of this AOI is not warranted.

4.16 AOI 18 - Existing Storm Sewer Outfall

This AOI consists of the Facility's storm sewer connection points (currently five locations) to the municipal storm sewer. A sixth connection point was abandoned during construction of the WWTP (AOI 13). The municipal storm sewers are located beneath West Edgar Rd (southeast ^(TN) of the Facility) and beneath Linden Avenue (northwest ^(TN) of the Facility). West Morses Creek is a nearby drainage way where storm water runoff from the Facility, other nearby commercial and industrial facilities, and municipal road runoff is discharged. West Brook (also know as Morses Creek in this area) flows into two small reservoirs on the TOSCO property, which then discharge into Morses Creek. Morses Creek ultimately discharges into the Arthur Kill. Storm water discharges are permitted at the Facility under General Permit #SW 5G3-NJ0088315 (NJPDES # NJG 0035 947-PI ID# 46155). The Facility's storm sewers are all active, with the exception of the one abandoned line, noted above.

Historic remedial actions for the Facility storm sewers have included: emergency containment of the spilled paint thinner after a release in 1988, emergency containment of spilled diesel fuel, the recovery of the spilled materials, and cleaning of the storm sewers affected by the releases. Refer to the CCR/PAR for details on these events.

A. Scope and Results

In Section 7.12.2, the RFI/RI Work Plan identified collection of sediment and stormwater samples at the outfall locations to determine whether a potentially significant release of hazardous constituents has occurred at these outfalls.

The following is a summary of the sampling activities conducted for each medium during the RFI/RI at AOI 18:

Sediment:

During the initial stage of RFI/RI field investigation, three sediment samples (AOI 18 B-1, AOI 18 B-3, and AOI 18 B-5) were obtained on January 8, 2003 from the five outfalls of the Facility's storm sewer. The sediment samples were analyzed for TCL VOCs (excluding AOI 18 B-5), TCL SVOCs, and TAL metals. Two of the outfalls could not be sampled due to lack of sediment present in the outfalls.

Due to elevated detections of PAHs and lead, sediment location AOI B-3 was re-sampled on November 6, 2003 and analyzed for selected TCL SVOCs and TAL metals. Sediment location AOI 18 S-4 was also sampled on November 6, 2003 and analyzed for TCL SVOCs and lead.

Three additional sediment samples (Stream 1, Stream 2, and Stream 4) were collected from the bottom of Morses Creek on February 23, 2004 and analyzed for lead. TCL SVOCs were not sampled at these locations because it was determined that off-Facility concentrations, based on the detections at the outfalls, would be similar and indistinguishable from anthropomorphic concentrations.

Stormwater

Due to elevated detections of PAHs and lead, three stormwater samples (AOI 18 B-3, AOI 18 B-3A, and AOI 18 B-4) were collected from storm sewers located on/adjacent to the facility on November 6, 2003 and analyzed for TCL SVOCs and lead.

Four additional stormwater samples (Stream 1, Stream 2, Stream 3, and Stream 4) were collected from Morses Creek on February 23, 2004 and analyzed for lead to evaluate the elevated detections of lead on-Facility. As discussed above, TCL SVOCs were not sampled at these locations because they would be similar and indistinguishable from anthropomorphic concentrations.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/	PCBs	Inorganics
Sediment	4	3	3	NA	4
Stormwater	3	NA	3	NA	3

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.16.1 through 4.16.4. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in sediment and stormwater collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has from the storm sewer system. The results of the comparison are summarized in Tables 4.16.1 through 4.16.4 and shown on Figures 20 and 21. These results were used during the RFI/RI field investigation to guide data collection.

Sediment

Table 4.16.1 and Figure 20 indicate that TCL VOCs from sediment samples AOI 18 B-1 and AOI 18 B-3 were not detected above the screening criteria discussed in Section 4.01.A, B and C (based on direct contact, vapor intrusion and migration to groundwater).

As indicated in Table 4.16.1 and Figure 20, certain PAHs (including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene - AOI -18 B-1 only) have concentrations in sediment at AOI 18 B-1, AOI 18 B-3, and AOI 18 B-4, that are higher than the screening criteria discussed in Section 4.01.A (based on direct contact). Sediment results from the sample collected at AOI 18 B-5, did exceed the screening criteria discussed in Section 4.01.A (based on direct contact).

Table 4.16.1 and Figure 20 also indicate that arsenic was detected at AOI-18 B-3 at concentrations above the screening criteria discussed in Section 4.01.A (based on direct contact). Lead was also detected above the screening criteria discussed in Section 4.01.A (based on direct contact) at locations AOI 18 B-3, AOI 18 B-3 (resample), and AOI 18 B-4. However, at sediment locations AOI 18 B-1 and AOI 18 B-5, lead concentrations were below the screening criteria discussed in Section 4.01.A (based on direct contact).

As indicated in 4.16.2 and Figure 21, results from subsequent sampling in Morses Creek, lead concentrations were below the screening criteria discussed in Section 4.01.A (based on direct contact).

Stormwater

As indicated in Tables 4.16.3 and Figure 20, PAHs were detected in sediment samples from AOI 18 B-3, AOI 18 B-3A, and AOI 18 B-4.

Lead was detected in stormwater at locations AOI-18 B-3, B-3A and B-4, at concentrations above the screening criteria discussed in Section 4.02.A (based

on drinking water). Subsequent stormwater samples obtained from Morses Creek (Table 4.16.4 and Figure 21) indicated that lead was below the screening criteria discussed in Section 4.02.A (based on drinking water).

C. Conclusions

As discussed above, storm sewer sediment samples indicated a potentially significant impact of certain PAHs above the screening criteria discussed in Section 4.01.A (based on direct contact) at three outfall locations. Stormwater appears to be unimpacted by these concentrations. Thus, it appears that the nature and extent have been adequately defined in the storm sewer for the risk evaluation presented in Section V.

Storm sewer sediment samples indicate a potentially significant impact of lead at three locations above the screening criteria discussed in Section 4.01.A (based on direct contact) at the Facility outfalls. Stormwater samples indicate a similar impact at the same sampling locations above the screening criteria discussed in Section 4.02.A (based on drinking water). Sediment and Stormwater samples collected from Morses Creek do not indicate an impact to this area. Thus, it appears that the nature and extent have been adequately defined in the storm sewer for the risk evaluation presented in Section V.

Further investigation is planned to identify the original source of PAHs and lead in the storm sewer system. The results of this investigation will be reported in an addendum to this RFI/RI Report.

4.17 AOI 20 - Bone Yard

AOI 20 consists of an area approximately 400 feet by 175 feet located to the south ^(PN) of the incinerator, on the east ^(PN) side of the main Facility building. This AOI was known as the "boneyard" for historically storing old equipment and materials until they could be reused, recycled or disposed, and was identified during review of historical aerial photographs. The area was initially observed in an aerial photograph taken on April 7, 1951, and in an expanded form on an aerial photograph taken on November 20, 1958, with further expansion noted on a historical aerial photograph dated April 17, 1961. At some point subsequent to the 1961 photograph, the use of the area was apparently discontinued. The area appears to be paved and to be partially used for vehicle storage in an aerial photograph dated April 11, 1967. The equipment storage area appears to have been inactive since at least 1967, and the area is presently completely covered with pavement. No previous investigations of soil or water quality for this area have been conducted prior to the RFI/RI.

A. Scope and Results

The RFI/RI scope of work for AOI 20 included the collection of soil samples to determine whether a potentially significant release of hazardous constituents occurred as a result of the historic storage of used equipment in this area. The RFI sampling locations are shown on Figure 16d.

The initial phase of the RFI/RI investigation consisted of three soil borings (AOI 20 B-1 to AOI 20 B-3) installations completed on January 6, 2003. The borings were installed to provide even coverage of the area as discussed in the RFI/RI Work Plan. Soil samples were collected from these borings in accordance with the criteria described in the RFI/RI Work Plan. Soil samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, and PCBs.

Based on potentially significant PAHs and TAL metal concentrations detected in near surface and subsurface samples, nine additional sample locations (AOI 20 B-4 through AOI 20 B-12) were collected from July 28 through 29, 2003 for PAHs and TAL metals analyses (excluding AOI 20 B-10, AOI B-11, and AOI 20 B-12). The results from these nine sample locations also indicated potentially significant PAHs and TAL metals concentrations. Seven additional borings were installed November 11 and 12, 2003 (AOI 20 B-13 through AOI 20 B-19) and on November 19, 2003 to further characterize the extent of PAHs and TAL metals in soil.

No overburden groundwater samples were collected, since the results screening did not indicate a potential impact on groundwater.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	19	6	43	6	43

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil is shown in Table 4.17.1. In this table, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release

of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.17.1 and shown on Figures 16d and 17d.

Table 4.17.1 and Figure 16d indicates that PAHs (including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene) have concentrations in soil at AOI 20 higher than the screening criteria discussed in Section 4.01.A (based on direct contact). These concentrations were detected in both shallow and deep soil samples in the AOI. As shown on Figure 16d, the extent of PAHs have been adequately characterized for risk evaluation purposes.

Table 4.17.1 and Figure 17d also indicates that several TAL metals (arsenic and lead) have concentrations in soil at AOI 20 higher than the screening criteria discussed in Section 4.01.A (based on direct contact). These concentrations were detected in shallow soil samples at borings AOI 20 B-1, AOI 20 B-4 and AOI 20 B-5. As shown on Figure 17d, the exceedances at these borings have been bounded by soil samples that are lower than screening criteria for these metals.

As indicated on Table 4.17.1 and Figure 17d, several TAL metals (antimony, arsenic, cadmium, and chromium (total)) from shallow samples at AOI 20 B-1, AOI 20 B-4, and AOI 20 B-5, have concentrations higher than the screening criteria discussed in Section 4.01.C (based on migration to groundwater). However, the samples collected immediately above the water table were all lower than the screening criteria discussed in Section 4.01.C (based on migration to groundwater), as well as 4.01.A and B (based on direct contact and vapor intrusion). These metals were detected at the other locations lower than the screening criteria discussed in Section 4.01.A, B and C (based on direct contact, vapor intrusion and migration to groundwater). Further, the fact that the area is paved, with limited surface recharge, coupled with the decrease in metals concentrations in the deeper soil samples, indicates that groundwater would not likely be impacted by the elevated metal concentrations from the shallow soil.

No soil samples for TCL VOCs, TCL SVOCs, TAL metals and PCB at AOI 20 had concentrations higher than the screening criteria discussed in Section 4.01.B (based on vapor intrusion).

C. Conclusions

The RFI/RI soil data collected in AOI 20 indicate that a potentially significant release of several PAHs and metals has occurred. The presence of these constituents are believed to be associated with historic operations at the AOI. As presented in Figures 16d and 17d, RFI/RI soil sampling has adequately characterized the vertical and

horizontal extent of soil contamination in this AOI to perform a risk assessment of this AOI. The risk evaluation is presented in Section V.

Several TAL metals were detected in the shallow soil samples at AOI 20 above the screening criteria discussed in Section 4.01.C (based on migration to groundwater). However, the samples immediately above the water table from these locations were all lower than these screening criteria. In addition, soil samples from surrounding locations were also lower than these criteria. Given that this area is paved, which limits infiltration and the detection was only in the shallow soil sample, the vertical and horizontal extent has been adequately characterized in this AOI to perform a risk assessment of this AOI. The risk evaluation is presented in Section V.

4.18 AOI 21 - Waste Thinner Handling Area/Former Power House

Plant historical documents and other information, including letters to the regulatory agency, documented that paint solids and purge were historically used as a fuel supplement at the Facility. This practice started in 1979 and was terminated in 1984 or 1985. A letter from the GM-Linden Facility to NJDEP dated April 22, 1991 stated that, starting in June of 1979, purge solvent consisting of 65-percent toluol and 35-percent naphtha was introduced into the No. 6 fuel oil that was burned in the former Power House. The material was collected in 55-gallon drums from the purging of the paint lines. The drums were delivered to the southeast^(PN) corner of the former Power House, where their contents were transferred into a 500-gallon tote. For a brief period the GM-Linden Facility attempted to transfer purge directly into the fuel oil supply header. However, this was not successful, so the method reverted to transferring contents of drums into larger totes. After February 1, 1981, purge from the paint shop was placed into a 6,000-gallon above ground storage tank in the Paint Mix Building (AOI 6). The purge was transferred via pipe (AOI 2) from the tank in the Paint Mix Building to the basement of the former Power House. No documents were found that provided specific information regarding the configuration of the Powerhouse basement or how the purge was transferred from the basement to the supply header. It appears that the addition of purge to the No. 6 fuel oil was terminated in approximately August 1985. Until August 1985, purge that did not contain F-listed solvents was conveyed through a separate system that entered the boilers directly.

The Power House was dismantled in 1999. Drums of purge are no longer being stored in the vicinity of the former Power House, and purge is no longer being utilized as a fuel supplement at the Facility. Discussions with Facility personnel and review of available records did not indicate a release in this area had occurred. No previous investigations of soil or water quality for this area have been conducted prior to the RFI/RI.

A. Scope and Results

The scope of the RFI/RI field investigation at AOI 21 included the collection of soil samples to determine whether a potentially significant release of hazardous constituents occurred as a result of operational activities described above. The RFI sampling locations for soil are shown on Figure 16a.

The soil investigation at AOI 21 consisted of the installation of three soil borings (AOI 21 B-1 to AOI 21 B-3). The borings were installed on January 2 and 3, 2003, during the initial stage of the field investigation. Soil samples from these locations were collected in accordance with the Work Plan and analyzed for TCL VOCs and TAL metals. Due to the absence of constituents of concern in soil, as discussed below, no overburden groundwater samples were required.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Inorganics
Soil	3	6	NA	NA	6

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil is shown in Table 4.18.1. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.18.1 and shown on Figures 16a and 17a.

Table 4.18.1 indicates that no TCL VOCs were detected at AOI 21 with the exception of a low-level detection of 4-Methyl-2-pentanone. These results are all lower than the screening criteria discussed in Section 4.01.A, B, and C (based on direct contact, vapor intrusion, and migration to groundwater).

Table 4.18.1 also indicates that metals were detected at this AOI. However, all metal results were lower than the screening criteria discussed in Section 4.01.A, B, and C (based on direct contact, vapor intrusion, and migration to groundwater).

C. Conclusions

RFI/RI soil data collected at AOI 21 indicate that a potentially significant release of hazardous constituents has not occurred. Additional investigation and evaluation of this AOI is not warranted.

4.19 AOI 22 - Railroad Wells within Building Interior

Three sets of railroad tracks run north-south^(PN) from inside the building to the tracks located across Linden Avenue, north^(PN) of the Facility. Based on a review of historic aerial photographs these tracks have been present since at least 1940 and are still operated today. The tracks within the building are contained within railroad wells that are below the building's main floor. The railroad tracks have been used to transport raw materials to the Facility since the it was constructed. Raw materials are off-loaded from railroad cars located in the track wells. Based on interviews with GM employees, it is likely that releases have occurred historically to the railroad wells from spills to the building floor, which would have flowed to the track wells.

In addition, on May 22, 1999, a Conrail locomotive entered the plant to remove boxcars and struck the derailer, rupturing its fuel tank. According to the NJDEP incident report, the ruptured fuel tank resulted in a release of approximately 2200 gallons of diesel fuel to the ground beneath the railroad track. Approximately 700 gallon of diesel fuel entered a storm drain. The spilled material from the railroad wells was contained and then cleaned up by All-State Industrial Vac., Inc. The storm drains on-Facility were plugged and the storm line flushed with water. This fuel and water was removed using a vacuum truck and shipped off-Facility for treatment. A berm was built on Morses Creek to control runoff. The rail track was removed and the stone, gravel, and dirt were excavated and replaced with clean fill. The NJDEP provided a copy of a confirmation report indicating that the spill was not considered a discharge. Therefore, the NJDEP did not issue a letter of no-further-action for this incident, and considers the matter closed.

Sampling and remediation were conducted in 1999 during the cleanup of diesel fuel that resulted from a spill from a Conrail train (refer to CCR/PAR). No other investigations or remedial actions have been identified.

A. Scope and Results

The scope of the RFI/RI field investigation at AOI 22 initially included the collection of ten surficial soil samples to determine whether a potentially significant release of hazardous constituents occurred as a result of rail traffic in the building. Only one location was identified where soil rather than ballast or concrete was present under the tracks. Therefore, due to subsurface conditions encountered during the initial stage of soil investigation activities, only one soil boring could be completed (AOI 22 B-1),

which was sampled and analyzed for TCL VOCs and TCL SVOCs. The sample location is shown on Figure 16e.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Inorganics
Soil	1	1	1	NA	NA

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil each medium is shown in Table 4.19.1. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.19.1 and shown on Figures 16e.

Table 4.19.1 and Figure 16e indicated that no TCL VOCs were detected in the soil sample from AOI 22 B-1. Several TCL SVOCs were detected including, however all the detections were below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater)

C. Conclusions

RFI/RI soil data collected at AOI 22 indicate that a potentially significant release of hazardous constituents has not occurred. Additional investigation and evaluation of this AOI is not necessary.

4.20 AOI 23 - Former Interior Testing Pits

This AOI was identified through the review of Sanborn Maps from the 1950's and early 1960's, which indicated the presence of testing pits inside the main Facility building. The test pit areas were approximately 125 ft by 50 ft. Interviews conducted with GM representatives and file reviews, provided no further information on these pits. The pits are not present today. No previous investigations of soil or water quality for this area were conducted prior to the implementation of the RFI/RI.

A. Scope and Results

The scope of the RFI/RI field investigation at AOI 23 included the collection of soil and sump water samples to determine whether a potentially significant release of hazardous constituents occurred. The sample locations are shown on Figure 16e.

Soil Samples

Five soil borings (AOI 23 B-1 to AOI 23 B-5) were installed during the initial stage of the RFI/RI field investigation. The soil borings were installed in the suspected test pit locations. Soil samples from these locations were collected in accordance with the RFI/RI Work Plan and analyzed for TCL VOCs, TCL SVOCs and TAL metals.

Based on the potentially significant benzo(a)pyrene concentration at AOI 23 B-2, three additional borings (AOI 23 B-4a, AOI 23 B-5a and AOI 23 B-6) were installed during the second stage of the RFI/RI field investigation to further characterize the extent of benzo(a)pyrene in soil. Two soil samples (shallow and deep) were collected from each soil boring and analyzed for PAHs.

Sump Water

The water in the sump located north^(PN) of the two suspected test pit areas was sampled in April 2003 for TAL VOCs, TAL SVOCs TAL metals and PCBs in accordance with the RFI/RI Work Plan.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	8	9	15	NA	9
Sump Water	1	1	1	1	1

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.20.1 and 4.20.2. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and sump water were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents may have occurred in the area. The

results of the comparison are summarized in Tables 4.19.1 and 4.19.2 and shown on Figures 16e, 17e, 18a, 18b, and 19a.

Soil

As indicated on Table 4.20.1 and Figure 16e, the west^(PN) test pit soil samples from boring AOI 23 B-4 and AOI 23 B-5 for TCL VOCs and TCL SVOCs, and TAL metal concentrations were all below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater).

Also indicated on Table 4.20.1 and Figures 16e and 17e, soil samples from soil borings (AOI 23 B-1 to AOI 23 B-3) at the east^(PN) test pit had several detections of TCL VOCs, TCL SVOCs and TAL metals. The TCL VOCs and TAL metal detections were all below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater). The TCL SVOCs detections were all below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater), with the exception of benzo(a)pyrene, at AOI 23 B-2 from a depth of 11.5 to 12 feet. This concentration exceeded the screening criteria described in Sections 4.01.A (based on direct contact), but was below the screening criteria described in Sections 4.01.B and C (based on vapor intrusion and migration to groundwater). As discussed above, additional soil samples were collected during the second stage of the RFI/RI field investigation, which indicated concentrations of TCL SVOCs were below the screening criteria described in Sections 4.01.A, B, and C (based on direct contact, vapor intrusion, and migration to groundwater). The results indicate that the area has been adequately characterized for risk evaluation purposes.

Sump Water

As identified above, an aqueous sample from a sump in a wheel alignment pit inside the main plant building at the Facility. Although the procedures for collecting these type of grab groundwater samples were intended to minimize the potential for introducing contaminants (including soil particles and NAPL) into the sample by the sampling procedure itself, such influence could not be entirely eliminated due to the nature of the sample collection method. As such, these aqueous data do not necessarily represent groundwater quality at the water table. Therefore, these data were not used as bases for identifying the presence of a potentially significant release, but rather were used only to guide decisions regarding groundwater characterization. However, these data were compared with the screening criteria for groundwater, and the

comparison results have been included on screening summary tables as a point of reference.

As indicated on Table 4.20.2 and shown on Figures 18a, 18b, and 19a, the TCL VOCs, TCL SVOCs, and PCBs were all lower than the screening criteria discussed in Section 4.01.A, B and C (based on drinking water, vapor intrusion, and construction worker contact) in the sump sample.

Table 4.20.2 and Figure 19a indicates that manganese was detected above the screening criteria discussed in Section 4.01.A (based on drinking water), but lower than the screening criteria discussed in Section 4.01. B and C (based on vapor intrusion and construction worker contact).

C. Conclusions

As discussed above, benzo(a)pyrene was detected at AOI 23 B-2 from a depth of 11.5 to 12 feet in exceedance of the screening criteria described in Sections 4.01.A (based on direct contact). Additional soil borings surrounding this point were all below the screening criteria described in Sections 4.01.A. Thus, it appears that the nature and extent of this detection has been adequately characterized for further risk evaluation, presented in Section V.

Manganese was detected in the water sample collected from the sump above the screening criteria discussed in Section 4.01.A (based on drinking water). This does not appear to be an issue related specifically to this AOI, based on the soil results and sporadic detections across the Facility in groundwater above this screening criteria. Therefore, manganese in water/groundwater will be further evaluated as a Facility-wide issue in Section 4.27.

4.21 AOI 24 - Central and Tutone Sludge Areas

The Central Sludge Area, which is currently in use, receives water containing paint overspray from the paint booths in the paint shop. The process in the Central Sludge Area consists of removing paint sludge from the water. Most of the water is re-circulated back to the paint shop. Some water is conveyed to the WWTP through a diversion structure. The area consists of a 90,000-gal steel tank inside a concrete containment pit. According to the Facility's Discharge Prevention, Control and Countermeasures plan, the pit serves as secondary containment. In addition, a portion of the steel tank's contents is discharged to the concrete pit on a daily basis, which is then discharged to the WWTP. Approximately 350-gal of paint detackifier and 350-gal of sodium hydroxide are stored in totes near this pit. The pit also serves as secondary containment for the totes.

The TuTone Sludge area is constructed similar to the Central Sludge Area. Although this area is not currently in use, it was historically used to remove overspray in the Tutone spray booths. The water was treated in a manner similar to the Central Sludge operation, including a steel tank in the pit, with overflow from the tank being pumped from the pit to the WWTP.

No previous investigations of soil or water quality for these areas have been conducted prior to the RFI/RI. The RFI/RI Work Plan identified that the integrity of the concrete pits was to be verified.

A. Scope and Results

The scope of the RFI/RI field investigation at AOI 24 was to determine the integrity of concrete containment of both the Tutone and Central Sludge area. The locations of the Tutone and Central Sludge area are shown on Figure 16e. In January 2004, the containment pit in the Central Sludge Area was cleaned, inspected and backfilled with concrete.

No work has currently been performed at the TuTone Sludge Area. Clean-out and inspection of this area is scheduled to be performed during the next stage of the field investigation in July 2004. Results of these activities will be included in an addendum to this RFI/RI Report.

B. Discussion of Results

The Central Sludge Area pit was cleaned out and inspected in January 2004. The pit appeared to be intact, with no visible cracks or fractures present. The Central Sludge tank that received paint sludge was located inside secondary containment consisting of a concrete walled and bottomed pit producing an annular space between the two. This space had held fluids (overflow of tank, spillage, etc.) and was not dry prior to closure. During closure, the contractor emptied this annular space by pumping the fluid out into the tank to the WWTP. Upon completion of the inspection, the pit was filled with concrete.

C. Conclusions

RFI/RI activities at the Central Sludge Area determined that the pit was sound with no cracks or fractures present. The pit was filled in with concrete at the completion of the inspection. Results of the TuTone Sludge Area cleaning and inspection activities will be included in an addendum to this RFI/RI Report, once completed in July 2004.

4.22 AOI 25 – Former Drum Storage Area

During the implementation of the RFI/RI, an area of former drum storage was identified. Detailed review of photographs, taken during the 1960's expansion of the building, contained images of drum storage. The area was located north ^(PN) of the former northern ^(PN) limits of the building, prior to the expansion activities. No previous investigations of soil or water quality had been conducted for this area prior to the RFI/RI, therefore it was added to the scope of work for the RFI/RI.

A. Scope and Results

The scope of work identified in the RFI/RI work plan did not originally include AOI 25. Three soil borings (AOI 25 B-1, AOI 25 B-2, and AOI 25 B-3) were completed on August 1, 2003, during the second stage of the field investigation. Soil samples were collected from the shallow interval (0 to 2 feet), deep (immediately above the water table), and at a depth of approximately seven feet below ground surface. The soil samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, and PCBs.

Six additional soil borings (AOI 25 B-4 through AOI 25 B-9) were drilled during the period of December 9 through December 10, 2003 to further delineate this area. Soil samples were collected shallow (0 to 2 feet) and deep (immediately above the water table) at each boring and analyzed for PAH constituents only. No overburden groundwater samples were collected, due to the absence of constituents of concern in soil.

The number of locations from which samples were collected for soil during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	9	9	21	9	9

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.22.1. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.22.1 and shown on Figures 16 e and 17e.

The soil results indicate that certain PAHs (including benzo(a)pyrene, benzo(a)anthracene, benzo(k)fluoranthene, and dibenz(a,h)anthracene) were detected in borings AOI 25 B-1, AOI 25 B-3 (benzo(a)pyrene only), AOI 25 B-8 (benzo(a)pyrene only) at concentrations higher than the screening criteria discussed in Section 4.01.A (based on direct contact) in the surficial soil samples only. The concentrations of these PAHs at all the other boring locations and depths are lower than the screening criteria.

As identified in Table 4.22.1 and shown on Figures 16e and 17e, no detections were identified for TCL VOCs; one detection of PCBs; and multiple detections of TAL metals in soil. These concentrations, were all lower than the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater) at AOI 25.

C. Conclusions

As presented in Figures 16e and 17e, certain PAHs were detected at several locations above the screening criteria discussed in Section 4.01.A (based on direct contact). The detections appear to be bounded laterally and vertically, based on the additional soil sample results from the AOI. Other hazardous constituents were either not detected or below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater). Therefore, it appears that the horizontal and vertical extent of the potential release has been adequately characterized and further investigation is not warranted. Further risk evaluation of this data is presented in Section V.

4.23 AOI 26 – Suspected Abandoned UST

During the implementation of the RFI/RI investigation activities at AOI 10, a suspected vent line from a UST was discovered in the area. No records of a UST or previous investigations could be located, therefore the area was added to the scope of work for the RFI/RI.

A. Scope and Results

As indicated above, the scope of work in the RFI/RI Work Plan did not originally include AOI 26. On July 21, 2003, a geophysical survey utilizing ground penetrating radar was conducted in the area of the vent pipe to identify if a UST was present in the area. The survey identified an object that was in the shape of a UST, thus further investigation was warranted.

To determine whether a potentially significant release of hazardous constituents occurred at this AOI, five soil borings (AOI 26 B-1 to AOI 25 B-5) were completed

during second stage of the field investigation in July 2003. Soil samples were collected from above the water table and analyzed primarily for TCL VOCs (excluding AOI 26 B-2) and TPH. Samples from AOI 26 B-3 were also analyzed for TCL SVOCs. In addition, soil samples from AOI 26 B-1 were collected from below the water table at a depth of approximately 12.5 to 13.0 ft. for TCL VOCs, TCL SVOCs, TAL metals, and TPH

Based on potentially significant PAH concentrations detected in soil samples, four additional soil borings (B-6 through B-8 and B-1A) were completed on November 14, 2003 and samples were collected from the shallow interval (0 to 2 feet) and immediately above the water table (B-1A only a shallow sample was collected). In addition, an intermediate sample was collected from boring B-6 at a depth of 3.5 to 4 feet. Soil samples were analyzed for PAHs.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	TPH	Inorganics
Soil	9	5	10	6	1

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil is shown in Table 4.23.1. In this table, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred this AOI. The results of the comparison are summarized in Table 4.23.1 and shown on Figures 16c and 17c. These results were used during the RFI/RI field investigation to guide data collection.

Table 4.23.1 and Figure 16c indicates that benzo(a)pyrene at soil borings AOI 26 B-6 (intermediate sample) and AOI 26 B-7 (shallow sample) have concentrations in soil higher than the screening criteria discussed in Section 4.01 (based on direct contact), but below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and migration to groundwater). As shown on Figure 16c, the benzo(a)pyrene concentrations that exceed the screening criteria have been bounded by soil samples for AOI 26 or AOI 10 that are lower than screening criteria.

Table 4.23.1 and Figures 16c and 17c also indicates that TCL VOCs, TAL metals, and TPH results for AOI 26 were all below the screening criteria discussed in Section 4.01.A., B, and C (based on direct contact, vapor intrusion, and migration to groundwater).

C. Conclusions

As presented in Figures 16c and 17c, benzo(a)pyrene was detected at several locations above the screening criteria discussed in Section 4.01.A (based on direct contact). The detections appear to be bounded laterally and vertically, based on the additional soil sample results from the AOI 10 and AOI 26. Other hazardous constituents were either not detected or below the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater). Therefore, it appears that the horizontal and vertical extent of the potential release has been adequately characterized and further investigation is not warranted. Further risk evaluation of this data is presented in Section V. Additional evaluation of the geophysical anomaly in the suspected UST area, using excavation, is planned and will be included in an addendum to this RFI/RI Report.

4.24 AOI 27 – Stained Asphalt Area

AOI 27 was identified during the implementation of the RFI/RI field investigation activities. Surface staining was observed on the parking lot, during investigation of AOI 20. The staining appeared to emanate from an unused piece of equipment stored outside. No previous investigations of soil or water quality had been conducted for this area prior to the RFI/RI, therefore it was added to the scope of work for the RFI/RI.

A. Scope and Results

The scope of work identified in the RFI/RI work plan did not originally include AOI 27. One soil boring (AOI 27 B-1) was completed on August 1, 2003, during the second stage of the field investigation. Soil samples were collected from the shallow interval (0 to 2 feet), intermediate interval (approximately four feet) and deep (immediately above the water table) and analyzed for TCL VOCs, TCL SVOCs, TPH, and PCBs.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	TPH	PCBs
Soil	1	3	3	3	3

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for soil is shown in Table 4.24.1. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Table 4.24.1 and shown on Figures 16d and 17d.

The soil data indicated that there were no detections of TCL VOCs, TPH, and PCBs in any of the soil samples submitted for AOI 27. TCL SVOCs were detected, however the concentrations were all lower than the screening criteria described in Sections 4.01.A, B and C (based on direct contact, vapor intrusion, and migration to groundwater).

C. Conclusions

The RFI/RI soil data collected at AOI 27 indicate that a potentially significant release of hazardous constituents has not occurred. Additional investigation and evaluation of this AOI is not warranted.

4.25 AOI 28 – Southern ^[PN] Facility Boundary Area

AOI 28 represents a grouping of monitoring wells that were installed to characterize groundwater conditions along the Southern ^[PN] Facility Boundary Area, (ie. along West Edgar Road/Route 1). While, this AOI is not specifically associated with current or former operations being conducted in this area of the Facility, soil samples were collected at the time monitoring wells were installed to confirm the absence of potentially significant releases to soil that might affect the underlying groundwater quality.

A. Scope and Results

Soil Samples

A total of five soil sample locations were grouped into the Southern ^[PN] Facility Boundary Area. These soil locations include the following.

Preliminary Groundwater Investigation well cluster MW-17 was completed in July 2002. Soil samples were collected from the bedrock monitoring well in this cluster

from the shallow interval (0 to 2 feet), intermediate interval (approximately three feet) and deep (immediately above the water table) and analyzed for TCL VOCs.

Two additional well cluster locations (MW-27 and MW-28) were installed during the second stage of RFI/RI field investigation in August 2003. Soil samples were collected from the weathered bedrock well in the cluster from the shallow interval (0 to 2 feet) and deep (immediately above the water table) and analyzed for TCL VOCs, TCL SVOCs, and TAL metals.

Two additional weathered bedrock monitoring well locations (MW-29W and MW-30W), were installed to surround the MW-8 well cluster in October/November 2003. Soil samples were collected from the shallow interval (0 to 2 feet), intermediate interval (approximately three feet) and deep (immediately above the water table) and analyzed for TCL VOCs, TCL SVOCs, and TAL metals..

Groundwater Samples

A total of eleven monitoring wells were sampled as part of the Preliminary Groundwater Investigation and RFI/RI field investigation and grouped into the Southern ^[PN] Facility Boundary Area. Wells grouped into this area include overburden wells (BEC-8D, MW-17S, and MW-20S), weathered bedrock wells (MW-8W, MW-17W, MW-27W, MW-28W, MW-29W, and MW-30W), and bedrock wells (MW-8B and MW-17B).

Groundwater samples were collected from MW-17S, MW-17W, and MW-17B during the Preliminary Groundwater Investigation in August 2002 and analyzed for TCL VOCs.

During the initial stage of RFI/RI field investigation in January 2003, groundwater samples were collected from the overburden wells (BEC-8D and MW-17S), weathered bedrock wells (MW-8W and MW-17W), and bedrock well (MW-17B), and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and PCBs. Groundwater samples were collected from overburden well, MW-20S after installation in April/May 2003 and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and PCBs.

During the second stage of RFI/RI field investigation in October 2003, groundwater samples were collected from the overburden wells (BEC-8D, MW-17S, MW-20S), weathered bedrock wells (MW-8W and MW-17W), and bedrock well (MW-17B), and analyzed for TCL VOCs, TCL SVOCs, and TAL metals.

After installation of weathered bedrock wells, MW-27W, MW-28W, MW-29W, and MW-30, and bedrock well MW-8B, groundwater samples were collected in

November and December 2003 and analyzed for TCL VOCs, TCL SVOCs, and TAL metals.

The number of locations from which samples were collected for each medium during the RFI/RI, and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	PCBs	Inorganics
Soil	5	13	10	NA	10
Groundwater	11	21	11	6	17

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.25.1 to 4.25.3. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater samples collected during the RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether the area along the Southern^(PN) Facility Boundary has been impacted by a potentially significant release of hazardous constituents in the area or upgradient. The results of the comparison are summarized in Tables 4.25.1 to 4.25.3 and shown on Figures 16d, 17d, 18a, 18b, 18c, 18d, 19a, 19b, and 19c. These results were used during the RFI/RI field investigation to guide data collection.

Soil

Table 4.25.1 and Figure 16d indicate that certain PAHs (including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene) at MW-28W and MW-29W were detected in soil above the screening criteria discussed in Section 4.01.A (based on direct contact). These concentrations appear to be localized to the surface soils at boring MW-28W and MW-29W; the concentrations of these PAHs at all other boring locations and deeper depths are lower than the screening criteria. The TCL SVOC concentrations were all lower than the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and migration to groundwater).

Table 4.25.1 and Figure 16d also indicate that there were no detections of TCL VOCs. Hence, these results were all lower than the screening criteria

discussed in Section 4.01.A, B and C (based on direct contact, vapor intrusion and migration to groundwater).

As indicated in Table 4.25.1 and on Figure 17d, the shallow soil sample collected from MW-30W was above the screening criteria discussed in Section 4.01.C (based on migration to groundwater) for manganese. However, the intermediate sample and the sample immediately above the water table were all lower than the screening criteria discussed in Section 4.01.C (based on migration to groundwater) for manganese. Manganese at the other locations and other TAL metals were all lower than the screening criteria discussed in Section 4.01.A, B and C (based on direct contact, vapor intrusion and migration to groundwater).

Overburden Groundwater

As indicated in Table 4.25.2 and Figures 18a and 18b, trichloroethene was detected in MW-8D during each of the RFI/RI sampling events above the screening criteria discussed in Section 4.01.A (based on drinking water). However, at the adjacent shallower monitoring well, MW-20S, as well as at MW-17S, TCL VOCs were not detected. The detected concentrations of TCL VOCs were all below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and construction worker contact).

Table 4.25.2 and Figures 18a and 18b also indicate that TCL SVOCs were all lower than the screening criteria discussed in Section 4.01.A, B and C (based on drinking water, vapor intrusion, and construction worker contact).

As indicated in Table 4.25.2 and Figures 19a, several TAL metals (arsenic and manganese) were detected in MW-17S during each of the RFI/RI sampling events above the screening criteria discussed in Section 4.01.A (based on drinking water). Manganese was also detected in MW-20S above the screening criteria discussed in Section 4.01.A (based on drinking water) during the April 2003 sampling event, but was lower than the criteria during the October 2003 sampling event. These concentrations were all below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and construction worker contact). TAL metals were not detected in MW-8D, thus lower than the screening criteria discussed in Section 4.01.A, B and C (based on drinking water, vapor intrusion, and construction worker contact).

Weathered Bedrock Groundwater

Table 4.25.3 and Figure 18c indicate that certain TCL VOCs (including 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, and

trichloroethene) were detected in groundwater samples from MW-8W, MW-17W, MW-27W, and MW-28W) above the screening criteria discussed in Section 4.01.A (based on drinking water). Monitoring well, MW-8W, exhibited the highest concentrations of trichloroethene. However, at the upgradient adjacent monitoring wells to MW-8W, MW-29W and MW-30W, TCL VOCs were not detected during the November/December sampling event. All TCL VOC concentrations were below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and construction worker contact).

Table 4.25.3 and Figure 18c also indicated that TCL SVOCs and PCBs were either non-detect or lower than the screening criteria discussed in Section 4.01.A, B and C (based on drinking water, vapor intrusion, and construction worker contact).

As indicated in Table 4.25.3 and Figure 19b, manganese was detected at MW-17W, MW-29W, and MW-30W above the screening criteria discussed in Section 4.01.A (based on drinking water), but lower than the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and construction worker contact). The TAL metals results for the other wells in the area grouping (MW-8W, MW-27W, and MW-28W) were all lower than the screening criteria discussed in Section 4.01.A, B and C (based on drinking water, vapor intrusion, and construction worker contact).

Bedrock Groundwater

Table 4.25.3 and Figure 18d indicate several limited detections of TCL VOCs, and no detections of TCL SVOCs and PCBs. The detected TCL VOC concentrations of these compounds were all lower than the screening criteria discussed in Section 4.01.A, B, and C (based on drinking water, vapor intrusion, and construction worker contact).

Table 4.25.3 and Figure 19c also indicate that detections of manganese in MW-17B during two rounds of groundwater sampling above the screening criteria discussed in Section 4.01.A (based on drinking water), but lower than the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and construction worker contact). Groundwater results from MW-8B indicated concentrations all lower than the screening criteria discussed in Section 4.01.A, B, and C (based on drinking water, vapor intrusion, and construction worker contact).

C. Conclusions

As discussed above, PAHs were detected in the soil at concentrations in this grouped area, above the screening criteria discussed in Section 4.01.A (based on direct contact), but below the screening criteria discussed in Section 4.01.B and C (based on vapor intrusion and migration to groundwater). These concentrations appear to be localized to the surface soils at boring MW-28W and MW-29W. No historic information suggest a potential source for these detection, thus it appears that the area has been adequately characterized for vertical and horizontal extent for further risk evaluation presented in Section V.

Manganese was detected in the shallow soil sample from MW-30W was above the screening criteria discussed in Section 4.01.C (based on migration to groundwater). However, the intermediate sample and the sample immediately above the water table from this location were all lower than this screening criteria. In addition, soil samples from surrounding locations were also lower than this criteria. Given that this area is paved, which limits infiltration and the detection was only in the shallow soil sample, further investigation is not warranted. Further risk evaluation is presented in Section V.

Also as discussed above, manganese was detected in several overburden, weathered bedrock, and bedrock monitoring wells are above the screening criteria discussed in Section 4.01.A (based on drinking water), but below the screening criteria discussed in Section 4.01.B and C (vapor intrusion and construction worker contact). The source of these concentrations is not apparent. Deep soil concentrations of manganese would not suggest these levels of detections, and the groundwater concentrations appear random across this area and the Facility in general. Based on the Facility-wide manganese detections, it appears that the concentrations have been adequately characterized for further risk evaluation presented in Section V.

TCL VOCs, primarily trichloroethene and related chlorinated compounds, have been detected above the screening criteria discussed in Section 4.01.A (based on drinking water) in deep overburden and weathered bedrock groundwater, which exhibited the highest concentrations (MW-8W). The shallow overburden and bedrock groundwater are virtually absent of these constituents. In addition, TCL VOCs were not identified in any of the soil samples in this grouped area. This suggests that the potential source of the elevated trichloroethene in the area may be from the weathered bedrock groundwater zone. The upgradient weathered bedrock monitoring wells, MW-29W and MW-30W were below detection limits for TCL VOCs, suggesting that the potential source of trichloroethene may lie to the south of MW-8W. Additional field investigations are required to identify the source of these high chlorinated

concentrations. The results from these investigations will be reported in an addendum to this RFI/RI Report.

4.26 AOI 29 - Monitoring Well 18 Area

The monitoring well 18 cluster (overburden, weathered bedrock, and bedrock wells) was not installed to evaluate a suspected or potential release of hazardous constituents, rather was installed as a perimeter well cluster during the Preliminary Groundwater Investigation to help characterize Facility-wide groundwater conditions. However, detections of PAHs from the initial soil samples indicated a potential impact on soils in this area. Additional borings were conducted to evaluate this potential impact. No prior investigations of soil or water quality had been conducted in this area have been conducted prior to this work.

A. Scope and Results

The RFI/RI scope of work for AOI 29 involved the collection of soil samples to determine whether a potentially significant release of hazardous constituents has occurred in this area and whether these constituents may have impacted groundwater quality. The RFI/RI sampling locations are shown on Figure 16a, and included the following:

Soil Samples

During the Preliminary Groundwater Investigation, three monitoring wells (MW-18S, MW-18W and MW-18B) were completed in July 2002. Soil samples were collected from the shallow interval (0 to 2 feet) at MW-18W. Soil samples were collected from MW-18B from the shallow interval (0 to 2 feet) (TCL VOCs only), an intermediate depth (approximately 4 feet), and deep (approximately 8 feet) for TCL VOCs, TCL SVOCs, and TAL metals. Samples were obtained from MW-18B for TCL VOCs, TCL SVOCs, and TAL metals. No soil samples were collected from MW-18S.

As indicated above, detections of PAHs from the initial soil samples indicated a potential impact on soils in this area, therefore three soil borings (MW-18 B-2, B-3 and B-4) were completed and sampled on July 29, 2003. Samples were collected from shallow (0 to 2 feet) and intermediate (approximately 3 feet) depths in all three borings for TCL SVOCs. A deep sample (approximately 7 feet) was obtained in borings AOI-18 B-2 and B-3 and analyzed for TCL SVOCs.

Due to elevated TCL SVOC detections in MW-18 B-2, B-3 and B-4, three additional soil borings (AOI-18 B-5, B-6 and B-7) were completed and sampled on November 20, 2003. Soil samples were obtained from shallow (0 to 2 feet), intermediate (approximately 3 feet) and deep (approximately 7 feet) intervals from these borings and analyzed for TCL SVOCs.

Two supplemental soil borings (MW-18 B-8 and B-9) were completed and sampled on March 29, 2004. Soil samples were obtained from shallow (0 to 2 feet), intermediate (approximately 3 feet) and deep (approximately 7 feet) intervals for TCL SVOC analysis.

Groundwater

As part of the Facility-wide groundwater evaluation, groundwater samples were collected during three separate sampling events from MW-18S, MW-18W, and MW-18B for TCL VOCs (August 2002, January 2003, and October 2003), TCL SVOCs (January 2003), TAL metals (January 2003 and October 2003) and PCBs (January 2003).

The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs/ PAHs	PCBs	Inorganics
Soil	10	4	27	NA	4
Groundwater	3	6	6	3	6

The above sample counts do not include QC samples (e.g. field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.26.1 to 4.26.3. In these tables, concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples) are provided in Appendix E.

B. Discussion of Results

The concentrations of constituents detected in soil and groundwater collected during the Preliminary Groundwater Investigation and RFI/RI were compared with the screening criteria discussed in Section 4.0, to determine whether a potentially significant release of hazardous constituents has occurred at the area. The results of the comparison are summarized in Tables 4.26.1 to 4.26.3 and shown on Figures 16a, 17a, 18a, 18b, 18c, 18d, 19a, 19b and 19c. These results were used during the RFI/RI field investigation to guide data collection.

Soil

Table 4.26.1 and Figures 16a and 17a indicate that the soil results obtained in the Monitoring Well 18 Area several detections of TCL VOCs and TAL Metals, but all below all of the soil screening criteria identified in Section 4.0.

Table 4.26.1 and Figure 16a also indicate that detections of certain PAHs (including benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) at nine of the ten sampling locations in the Monitoring Well 18 Area were higher than screening criteria discussed in Section 4.01.A (based on direct contact). In addition, Table 4.24.1 and Figure 16a indicate that detections of certain PAHs (fluoranthene and pyrene) were higher than the screening criteria discussed in Section 4.01C (based on migration to groundwater) at MW-18 B-5 in the shallow and intermediate soil samples. The highest PAH concentrations were associated with soil boring MW-18 B-5, which was bounded by lower concentrations in the surrounding soil sample locations.

No concentrations from the Monitoring Well 18 Area were noted in Table 4.26.1 and Figures 16a and 17a to be above the screening criteria discussed in Sections 4.01.B (based on vapor intrusion).

Overburden Groundwater

Table 4.26.2 and Figures 18a, 18b, and 19a indicate that limited number of detections of TCL VOCs, TCL SVOCs, and TAL metals, with no detections of PCBs in the overburden groundwater from MW-18S. All of the results for TCL VOCs, TCL SVOCs, and PCBs were below the screening criteria described in section 4.02 (based on drinking water, vapor intrusion, and construction worker contact).

Arsenic and manganese were detected in two sampling events (January and October 2003) from MW-18S above the screening criteria described in Section 4.02.A (drinking water criteria).

Weathered Bedrock and Bedrock Groundwater

Weathered bedrock and bedrock groundwater are evaluated in this section in relationship to the potential/suspect impact identified in the soils results above. Because the MW-18 cluster is part of the Facility-wide perimeter groundwater monitoring network, weathered bedrock and bedrock groundwater are further discussed in Section 4.27.

Table 4.26.3 and Figures 18c, 18d, 19b, and 19c indicate that PCBs were not detected in groundwater for any samples obtained from MW-18W and MW-18B. Several TCL VOCs (including 1,2-dichloroethane, benzene, carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene, trichloroethene, and vinyl chloride), were detected in two to three of the groundwater sampling events in the weathered bedrock well MW-18W and

bedrock well MW-18B above the screening criteria described in Section 4.02.A (based on drinking water). In addition, TCL SVOC (bis(2-chloroethyl)ether) and TAL metal (manganese) were detected in the January 2003 groundwater sampling events in the weathered bedrock well MW-18W above the screening criteria described in Section 4.02.A (based on drinking water). No exceedances of the other screening criteria described in Section 4.02.B&C (based on vapor intrusion and construction worker contact) were identified in the weathered bedrock and bedrock groundwater at the MW-18 cluster.

C. Conclusions

The soil data collected as part of the Preliminary Groundwater Investigation and RFI/RI investigation in the Monitoring Well 18 Area indicate that a potentially significant release of hazardous constituents may have occurred. PAHs were present in the soil at concentrations that exceeded screening criteria discussed in Section 4.01.A (based on direct contact) in shallow and intermediate soil samples. The extent of the area appears to be adequately characterized and is bounded by lower concentrations from surrounding soil samples. These concentrations do not appear to affect overburden groundwater in this area. Based on this information, further risk evaluation is presented in Section V.

Based on the overburden, weathered bedrock, and bedrock groundwater data collected as part of the Preliminary Groundwater Investigation and RFI/RI investigation in the Monitoring Well 18 Area, TCL VOCs, TCL SVOCs, and TAL metals were detected above the screening criteria described in Section 4.02.A (drinking water criteria). However, based on the soil results and Facility-wide groundwater data, these results do not appear to be related to releases in soil in this area. Regardless, further risk evaluation is presented in Section V. Weathered bedrock and bedrock groundwater are further discussed below.

4.27 Facility-Wide Groundwater Quality

In addition to evaluation of the groundwater quality data as part of the individual AOIs, as described above, the following sections evaluate groundwater quality in each of the major hydrogeologic units on a Facility-wide basis. In addition, the following sections incorporate the results of the perimeter wells, which have not been associated with an AOI.

A. Overburden Groundwater Quality

Table 4.27.2 and Figures 18a, 18b, and 19a indicate that a limited number of detections of TCL VOCs (including bis(2-chloroethyl)ether, 1,1-dichloroethene, 1,2-dichloroethane, benzene, bromodichloromethane, chloroform, tetrachloroethene,

trichloroethene, and vinyl chloride), TCL SVOCs (benzo(a)anthracene and benzo(a)pyrene), and several TAL metals (including arsenic, barium, cadmium, lead and primarily manganese) above the screening criteria described in Section 4.02.A (based on drinking water) in the overburden groundwater (shallow and deep). No exceedances of the other screening criteria described in Section 4.02.B and C (based on vapor intrusion (occupational) and construction worker contact) were identified in the overburden groundwater. Many of the exceedances, including manganese in particular, do not appear to be associated with Facility activities and also appear as exceedances in the monitoring wells on the upgradient side of the Facility (north^(PN) side). In addition, as discussed in Section 3.09, overburden groundwater is not utilized in the vicinity of the Facility as a potable drinking water source.

Therefore, a surrogate set of overburden wells were selected on the downgradient Facility and evaluated against more representative exposure pathways, including residential vapor intrusion from groundwater and direct contact. As indicated in Table 4.27.2 and Figure 22 indicate that only arsenic and manganese exceed the screening criteria described in Section 4.02.A (based on drinking water). No exceedances of the other screening criteria described in Section 4.02.B and C (based on vapor intrusion (residential) and direct contact (residential)) or TCL VOCs and TCL SVOCs for all three criteria were identified in the overburden groundwater. As indicated above, arsenic and manganese were detected above the screening criteria (based on drinking water) in the monitoring wells on the upgradient side of the Facility. This suggests that detections of these compounds may be unrelated to Facility activities. Regardless, further risk evaluation is presented in Section V.

B. Weathered Bedrock Groundwater Quality

Table 4.27.3 and Figures 18c and 19b indicate that several detections of TCL VOCs (including 1,1,2-trichloroethane, 1,1-dichloroethene, 1,1-dichloroethene, 1,2-dichloroethane, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, trichloroethene, and vinyl chloride), TCL SVOCs (bis(2-chloroethyl)ether), and TAL metals (arsenic and manganese) were above the screening criteria described in Section 4.02.A (based on drinking water) in the weathered bedrock. In addition, based on an evaluation of well construction, it is believed that many of the detections in the deep wells in the overburden, discussed above, may be associated with the weathered bedrock zone.

Many of the detections above the screening criteria do not appear to be associated with Facility activities, are upgradient of facility activities, or the concentration gradient does not match the direction of groundwater flow. One of these areas is the detection of 1,1-dichloroethene and trichloroethene at MW-8W, where the immediately upgradient wells (MW-29W and MW-30W) are non-detect for TCL

VOCs. The area immediately surrounding MW-8W has been limited to a parking lot. This potentially suggests an off-Facility source, although off-Facility may actually be downgradient of MW-8W. Further investigation will be conducted in this area. The results of this investigation will be included in an addendum to the RFI/RI.

There are several other areas, including MW-15W, MW-16W, MW-35W, and MW-36W, where the wells are located on the upgradient side of the Facility or historic Facility activities do not indicate an on-Facility source. Detections of bis(2-chloroethyl)ether, which is associated with pharmaceutical activities, at many of the locations where chlorinated organics are identified, suggest a possible link to the nearby Merck site. Additional investigations are planned to identify the source of the high TCL VOC concentrations found in the weathered bedrock at on-Facility and off-Facility locations. The results from these investigations will be reported in an addendum to this RFI/RI Report.

C. Bedrock Groundwater Quality

Table 4.27.3 and Figures 18d and 19c indicate that several TCL VOCs (1,1,2-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride), TCL SVOCs (bis(2-chloroethyl) ether), and TAL metals (manganese) were detected above the screening criteria described in Section 4.02.A (based on drinking water) in the bedrock.

At several locations where exceedances of chlorinated organics were identified (BEC-4B) or historically identified (BEC-3B), a review of hydrogeologic test information and well construction indicates that the water quality results may not accurately represent the bedrock aquifer. Rather, the data suggest that the exceedances may be a result from influence of the weathered bedrock interval and poor well construction. Monitoring well BEC-3B has been replaced and the replacement well, MW-8B has not exceeded the screening criteria since installation. Monitoring well BEC-4B is currently scheduled to be replaced with a well cluster consisting of a weathered bedrock and bedrock monitoring well. In addition, the detections in the bedrock zone are typically one or more orders of magnitude less than the weathered bedrock zone. Additional hydrogeologic testing of the interaction between the weathered bedrock and bedrock zones is planned.

Similar to the weathered bedrock interval, there are several other areas, including MW-15B and MW-16B, where the wells are located on the upgradient side of the Facility or historic Facility activities do not indicate an on-Facility source. Detections of bis(2-chloroethyl)ether, which is associated with pharmaceutical activities, were

also identified at many of the locations where chlorinated organics are identified, suggest a possible link to the nearby Merck site. Additional investigations are planned to identify the source of the high TCL VOC concentrations found in the bedrock at on-Facility and off-Facility locations. The results from these investigations will be reported in an addendum to this RFI/RI Report.

V. HUMAN HEALTH RISK EVALUATION

5.01 Introduction

The human health risk assessment discussed in this section uses the site characterization data that have been collected during the RFI field investigation to evaluate the potential significance of reasonable maximum exposures under current and reasonably expected future land use at and around the Facility. The results of the risk assessment are used to identify where a release of hazardous waste or constituents from the Facility may cause reasonable maximum exposures to be significant enough to warrant corrective measures.

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) shown in Table 5.1. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Facility in terms of the potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The CSM was developed based on the site information and data discussed in Sections 3 and 4, respectively. The scenarios for potential human exposure are further discussed in Section 5.04.

Discussion of the human health risk assessment is organized as follows:

- The preparation of data used in the risk assessment is discussed in Section 5.02 – Data Collection and Preparation.
- Section 5.03 – Potentially Significant Releases summarizes the areas and environmental media that have been affected by a potentially significant release, and the primary constituents found in these media.
- The scenarios for potential human exposure are discussed in Section 5.04 – Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.
- Toxicity information for the constituents included in the risk assessment is summarized in Section 5.05 – Toxicity Assessment.
- The risks associated with the potential exposures discussed in Section 5.04 are quantified and their significance is discussed in Section 5.06 – Risk Characterization. Uncertainties associated with the risk estimates are also discussed in this section.
- The findings and conclusions of the human health risk assessment are summarized in Section 5.07 – Summary and Conclusions.

The methods used in the risk assessment are based on USEPA risk assessment guidance, and the interpretation of the risk assessment results is based on USEPA risk management policies for RCRA corrective action.

5.02 Data Collection and Preparation

A. Data Collection

The objectives of data collection during the RFI and strategies for determining when additional data collection is necessary were described in the RFI Work Plan (Haley & Aldrich 2002) and subsequent addenda. The scope of the RFI field investigation completed to date and a summary of the data collection activities are described in Section 2 of this report.

B. Data Preparation

Validation of data collected during the RFI was performed in accordance with the QAPP in the RFI Work Plan. All soil, groundwater, sediment, surface water, borehole water, stormwater, sump water, and LNAPL data included in the data summary tables for each area discussed in Section 4 were validated. In addition, the following procedures were used to prepare the data in these summary tables to support quantitative risk assessment. These procedures, which are based on USEPA guidance on human health risk assessment (USEPA 1989), are as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ-qualified data) during data validation are evaluated as non-detects.
- Constituent concentrations qualified as not usable (i.e., R-qualified data) during data validation are not included in the risk assessment.
- Constituents qualified as tentatively identified compounds (TICs) during data validation are not included in the risk assessment.
- Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment.
- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.

- The concentrations of 1,3-dichloropropene (total), methylphenol (total), and xylenes (total) in a sample are the sums of the concentrations of the detected isomers and half the quantitation limits of isomers not detected in the sample but detected in the same matrix at the Facility. If no isomer is detected in a sample, the constituent is considered to be not detected in the sample.
- Similarly, the concentration of PCBs (total) in a sample is the sum of the concentrations of the detected Aroclors and half the quantitation limits of Aroclors not detected in the sample but detected in the same matrix at the Facility. If no Aroclor is detected in a sample, PCBs are considered to be not detected in the sample.
- As a conservative assumption, all concentrations of organic and inorganic constituents are assumed to be site-related, since the RFI field investigation did not attempt to establish a site-specific background level for any constituent (as discussed in Section 3.07).

The RFI soil, groundwater, sediment, surface water, stormwater, and LNAPL data are used in the risk assessment, but groundwater data from boreholes and the sump in the former wheel alignment pit are not used because they were collected primarily to support the RFI field investigation and they do not necessarily represent groundwater quality in the aquifer, as discussed in Section 4. The aqueous sample collected from beneath the LNAPL at AOI 6 is used in the risk assessment to evaluate potential exposures of construction workers during excavations that extend to the water table at this AOI. No constituent that was affirmatively identified in any of these media is excluded from the risk assessment, except as noted above. The complete RFI data (including R-qualified data, TICs, and separate results for each sample of a duplicate pair) are provided in Appendix E. Summaries of the data validation results are provided in Appendix G.

5.03 Potentially Significant Releases

A. Soil

The Section 4 tables summarize the soil characterization data for each area, and show the ratios of the highest measured concentrations for each constituent at each area to the screening criteria. As discussed in Section 4.01, the screening criteria used to guide the RFI soil characterization efforts included criteria that are based on direct contact, vapor intrusion, and migration to groundwater. A potentially significant release to soil at an area is identified in the Section 4 tables by comparing the highest concentration of each constituent in surface and subsurface soil at the area to these screening criteria. Ratios of the highest concentrations in surface or subsurface soil to

the screening criteria that exceed 1 are considered indications of a potentially significant release to soil. As shown in the Section 4 tables, the ratios for certain constituents exceed 1 at the following AOIs:

- AOI 3 - Existing Drum Storage Area/Fill Area
- AOI 6 - Paint Mix Building
- AOI 7 - Former Bulk Fluids AST
- AOI 8 - Former Powerhouse Heating Oil ASTs
- AOI 10 - Former Storage Shed
- AOI 11 - Former Reclamation Area
- AOI 20 - Bone Yard
- AOI 23 - Former Interior Testing Pits
- AOI 25 - Former Drum Storage Area
- AOI 26 - Abandoned UST
- AOI 28 - Southern Boundary Area
- AOI 29 - MW 18 Area
- General (soil samples collected during site-wide groundwater investigations)

At each of these AOIs, concentrations of one or more polycyclic aromatic hydrocarbons (PAHs) are higher than the screening criteria based on direct contact. At AOIs 6, 7, 10, 11, and 20, metals such as arsenic and lead have concentrations that are higher than the screening criteria based on direct contact and/or migration to groundwater. AOI 6 and AOI 7 have VOCs at concentrations in soil that are higher than the screening criteria based on direct contact and/or migration to groundwater. At AOI 6, these VOCs are primarily TCE and BTEX (i.e., benzene, toluene, ethylbenzene, and xylene), and at AOI 7, they include only BTEX. No constituent has a concentration in soil that is higher than the screening criteria based on vapor intrusion.

In addition to the soil data summarized in the Section 4 tables, chemical characterization data for LNAPL were collected during the RFI at AOI 6. The LNAPL characterization data are summarized on Table 4.08.6. Although soil sampling at this area with LNAPL did not specifically target the depth interval in which the LNAPL layer fluctuates with the water table (i.e., the smear zone), upper-bound concentrations of LNAPL constituents in smear zone soil have been conservatively estimated in this risk assessment, as discussed in Section 5.04.D.1.

The potential for human exposure to constituents in soil at all the areas where field investigations were conducted during the RFI, including the areas where a potentially significant release was identified, is discussed in Section 5.04. The significance of the potential exposures is discussed in Section 5.06.

B. Groundwater

Groundwater quality data were collected during the RFI from the shallow and deep overburden, weathered bedrock, and bedrock monitoring wells at the Facility, as discussed in Section 3. The Section 4 summary tables for groundwater data show the ratios of the highest concentrations in each of these water-bearing units to the screening criteria. As discussed in Section 4.02, the screening criteria used to guide the RFI groundwater characterization efforts included criteria that are based on drinking water consumption, vapor intrusion, and construction worker contact. The criteria based on vapor intrusion and construction worker contact were used for evaluating only the groundwater quality data from the shallow overburden.

A potentially significant release to groundwater is identified in the Section 4 summary tables for groundwater by ratios of the highest concentrations to the screening criteria that exceed 1. Although the screening criteria used for identifying a potentially significant release to groundwater include drinking water criteria, the saturated zone in the overburden at and around the Facility is not a current or reasonably expected future potable water supply. As discussed in Section 3, the Facility and areas in the immediate vicinity are supplied with potable water from the Elizabethtown Water Company, which is obtained from the Raritan River, Millstone River, and the Delaware and Raritan Canal.

As shown in the Section 4 summary tables for groundwater, constituents with concentrations in shallow overburden groundwater that are higher than the screening criteria consist primarily of metals (such as cadmium and manganese) and a few VOCs (such as benzene and TCE). Concentrations of these constituents are higher than only the drinking water criteria, and are lower than the screening criteria based on vapor intrusion and construction worker contact.

Concentrations in the deep overburden, weathered bedrock, and bedrock groundwater that are higher than the screening criteria based on drinking water consumption are associated with a much larger number of VOCs (predominantly benzene, carbon tetrachloride, 1,2-DCA, methylene chloride, PCE, TCE, and vinyl chloride) and BCEE. However, some of these constituents do not appear to be associated with a release from the Facility, as discussed in Section 4. For example, more VOCs were found in the deeper saturated zones, and the concentrations are often much higher than those in the shallower saturated zones. Also, some of these constituents (such as carbon tetrachloride, 1,2-DCA, and BCEE) were found in only the deeper saturated zones, not found in either shallower groundwater or in any of the soil samples collected during the RFI, and not known to have been used in the Facility's operations.

The potential for human exposure to constituents in groundwater is discussed in Section 5.04, and the significance of any potential exposures is discussed in Section 5.06.

C. Sediment in Storm Sewers and Morses Creek

Sediment data were collected during the RFI from storm sewers and Morses Creek, as discussed in Section 4.16. The Section 4 summary tables for sediment data show the ratios of the highest concentrations detected in sediments from storm sewers to the screening criteria. As discussed in Section 4.03, the screening criteria used to guide the RFI sediment characterization efforts in storm sewers and Morses Creek were the soil screening criteria based on direct contact for industrial and residential soil, respectively.

As shown in Table 4.16.1, the ratios for PAHs, arsenic, and lead exceed 1 in the storm sewer sediments on-site. The highest concentration of lead in sediment samples from Morses Creek is 101 mg/kg, which is much lower than the conservative screening criterion that is based on residential soil exposure. The potential for human exposure to constituents in these sediments is discussed in Section 5.04, and the significance of any potential exposure is discussed in Section 5.06.

D. Stormwater and Surface Water from Morses Creek

Water samples were collected during the RFI from storm sewers and Morses Creek, as discussed in Section 4.16. The Section 4 summary tables for stormwater and surface water data show the ratios of the highest concentrations detected in these media to the screening criteria. As discussed in Section 4.04, the screening criteria used to guide the RFI characterization efforts for stormwater and surface water included the groundwater screening criteria that are based on drinking water consumption.

As shown on Table 4.16.3, the ratios for total and dissolved lead exceed 1 for stormwater. However, the highest detected surface water concentration for lead (0.003 mg/L) is well below the drinking water criterion of 0.015 mg/L, as shown on Table 4.16.3. The potential for human exposure to constituents in stormwater and surface water is discussed in Section 5.04, and the significance of any potential exposure is discussed in Section 5.06.

5.04 Exposure Assessment

This section discusses the potential exposures that are relevant under current and reasonably expected future land use at and around the Facility. The exposure setting, potentially exposed populations, and exposure pathways are discussed in the subsections below.

For the potential exposures discussed in this section, exposure is quantified as a dose, which is defined as follows:

$$\text{Dose} = \text{Concentration} \cdot \text{Intake}$$

The dose for evaluating cancer risk is averaged over a lifetime and is called a lifetime average daily dose (LADD). For evaluating long-term (or chronic) noncancer effects, the dose is averaged over the period of exposure and is called an average daily dose (ADD).

The concentration term in the dose equation refers to the concentration in an environmental medium to which a population is exposed over a specified period. The intake term refers to the intake rate of the contaminated environmental medium, which is a function of the magnitude, frequency, and duration of exposure. The methods for estimating the concentration term are discussed in Section 5.04.D. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 5.04.E.

A. Exposure Setting

The environmental setting at and around the Facility, including climate, geology, hydrogeology, land cover, surface water bodies, water supply, and groundwater use, are discussed in Section 3, and are not repeated in this section.

B. Potentially Exposed Populations

Based on the discussion of land use at and around the Facility in Section 3.08, the potentially exposed populations at and around the Facility under current and reasonably expected future land use include the following:

<u>Current</u>	On-Site:	Routine workers
	Off-Site:	Residents
		Routine workers
		Construction workers
		Recreational waders in Morses Creek

<u>Future</u>	On-Site:	Routine workers Construction workers Trespassers
	Off-Site:	Residents Routine workers Construction workers Recreational waders in Morses Creek

The main on-site receptor population consists of "routine workers," who typically spend most of the work day indoors conducting commercial or industrial activities. When outdoors, these routine workers are not currently exposed to surface soil because the Facility is completely paved. Routine workers, however, could be exposed to volatile constituents in subsurface soil or shallow groundwater via vapor migration into indoor air. A small fraction of the workers ("construction workers") at the Facility conduct occasional subsurface construction or maintenance activities (e.g., installation or repair of underground utilities, or removal or repair of pavement). However, construction activities at the Facility are currently covered by the Facility's health and safety plan, which ensures that construction workers would not have the potential for significant exposures during subsurface excavations. Therefore, under current conditions, the only potentially exposed population on-site is routine workers.

The Facility is expected to remain commercial/industrial. In the future, potentially exposed populations at the Facility are expected to include routine workers and construction workers. In areas where surface soil becomes exposed, trespassers also could be potentially exposed.

Under current conditions, the potentially exposed populations in off-site areas include residents, routine workers, construction workers, and recreational waders in the section of Morses Creek that is downstream of the municipal sewer in Linden Avenue which receives stormwater from the Facility. As discussed in Section 3.09, exposure to groundwater via potable or non-potable use is not expected in the downgradient vicinity of the Facility. However, residents and workers at properties immediately downgradient of the Facility could be exposed to volatile constituents in shallow groundwater via vapor migration into indoor air. Construction activities that extend into the water table downgradient of the Facility also could expose workers to constituents in the shallow groundwater. Under future conditions, nearby residents and routine workers also could be potentially exposed to constituents in soil at the Facility due to windblown dust and vapors if parts of the Facility were to become unpaved.

C. Exposure Pathways

The exposure pathways evaluated in the risk assessment are summarized in the conceptual site model shown on Table 5.1. Exposure pathways for on-site receptors are discussed in Section 5.04.C.1, and exposure pathways for off-site receptors are discussed in Section 5.04.3.2.

1. Potential On-Site Exposures

On-site receptors include routine workers, construction and maintenance workers, and trespassers. The types of potential exposures for each receptor are discussed below.

Routine Workers

Routine workers are expected to be engaged in commercial and/or industrial activities that generally take place indoors. During limited time outdoors, workers could contact soil in unpaved areas if existing pavement were to be removed; the Facility is essentially entirely paved currently. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

These workers also could be exposed to constituents in subsurface soil if the constituents were to volatilize and migrate through cracks in a building foundation into indoor air. Similarly, these workers could be exposed to constituents in groundwater if the constituents volatilize and migrate through cracks in a building foundation. Exposure to constituents in the LNAPL at AOI 6 via vapor intrusion is also possible, if a building were to be constructed over the LNAPL area at MW-19S which is currently outdoors.

Exposure of workers via potable groundwater use is not expected because groundwater is not used as a drinking water supply at the Facility or in the vicinity, and future potable use of groundwater is not reasonably expected, as discussed in Section 3.09.

Construction Workers

Currently, the Facility's health and safety plan addresses potential exposures to workers who are involved with construction or maintenance activities at the Facility. In the future, a small fraction of the workers at the Facility could conduct occasional subsurface construction or maintenance, which could put them in contact with surface and subsurface soil in paved and unpaved areas of the

Facility: If repairs or maintenance is performed on the stormwater system, construction workers also could contact stormwater and sediment in the sewer. Such subsurface activities are expected to be of limited size and duration. Potential routes of exposure to soil would include incidental ingestion, dermal contact, and inhalation of vapor and airborne particulates. Potential routes of exposure to sediment in storm sewers would include incidental ingestion and dermal contact, while potential exposure to stormwater would include incidental ingestion, dermal contact, and inhalation of vapor.

Construction workers also could be exposed to LNAPL and LNAPL-containing soil in the smear zone at AOI 6. The most potentially significant routes of exposure to LNAPL are expected to include dermal contact and inhalation of vapor. Potential routes of exposure to LNAPL-containing smear zone soil would include incidental ingestion, dermal contact, and inhalation of vapor.

In excavations that encounter groundwater, which is typically found between 9 to 11 ft below ground surface at and around the Facility, construction workers could be exposed to shallow groundwater. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor.

Construction worker exposures to soil in this risk assessment are indirectly evaluated using risk estimates for routine workers, except at AOIs 3, 6, 7, 11, 20, and 29. This streamlines the risk assessment and is conservative because construction worker exposures to soil during occasional excavations would be lower than routine worker exposures to soil (ENVIRON 2003). For construction worker exposures to soil at AOIs 3, 6, 7, 11, 20, and 29, the risk estimates are refined by using exposure assumptions that are specific to construction workers. For the LNAPL area at AOI 6, construction worker exposures are evaluated directly, as discussed in Appendix M.

Trespassers

Potential exposure of trespassers is possible in the future, although fencing and plant security would control access to the Facility. These controls would make trespassing unlikely, and would limit the duration of any unauthorized access as well as the types of activities while on-site. While on-site, trespassers could come into contact with soil in unpaved areas if existing pavement were to be removed; the

Facility is essentially entirely paved currently. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

Trespasser exposures to soil in this risk assessment are indirectly evaluated using risk estimates for routine workers. This streamlines the risk assessment and is conservative because trespasser exposures to soil would be lower than routine worker exposures to soil (ENVIRON 2003).

2. **Potential Off-Site Exposures**

Off-site receptors include residents, routine workers, construction or maintenance workers, and recreational waders in Morses Creek. The types of potential exposures for each receptor population are discussed below.

Residents

As discussed in Section 4, the soil characterization data collected during the RFI show that the extent of potentially significant releases to soil does not extend to locations near any off-site residential areas. Therefore, the only potential exposure of off-site residents to soil constituents is via airborne transport from on-site soil that would become exposed if existing pavement were to be removed. In this risk assessment, such potential exposures are indirectly evaluated using risk estimates for on-site routine workers. This approach streamlines the risk assessment and is conservative because airborne exposures off-site are expected to be lower than exposures on-site due to much greater air dispersion between an on-site emission source and off-site receptors as compared to air dispersion directly over an emission source.

Groundwater is not a current or reasonably expected future water supply at residences in the vicinity of the Facility, as discussed in Section 3.09. Therefore, potential exposure via potable and non-potable groundwater use is not evaluated in the risk assessment. Potential exposure is possible if constituents in shallow groundwater volatilize and migrate through cracks in building foundations.

Routine Workers

As discussed in Section 4, the soil characterization data collected during the RFI show that the presence of potentially significant

concentrations of a few constituents extend to some locations along the Facility's western and eastern boundaries, which are near unpaved areas at adjacent industrial properties. The data for these constituents show that the concentrations along these boundaries appear to decrease toward the boundaries so that concentrations off-site are not expected to be significantly higher than the concentrations on-site. Potential exposure of off-site workers to these constituents, assuming they are present in the unpaved off-site areas, is conservatively evaluated in this risk assessment using risk estimates for exposure of on-site workers to soil along these portions of the Facility boundaries.

Off-site workers also could be exposed to constituents in shallow groundwater if the constituents volatilize and migrate through cracks in building foundations. These potential exposures are indirectly evaluated in this risk assessment by using exposure estimates for residents. This streamlines the risk assessment and is conservative because residential exposures via vapor intrusion are expected to be higher than that for routine workers.

Exposure of workers via potable or non-potable groundwater use is not expected because groundwater is not a current or reasonably expected future water supply in the vicinity of the Facility as discussed in Section 3.09.

Construction Workers

Off-site workers involved in maintenance or repair of municipal storm sewers could be exposed to sediment and stormwater from GM's storm sewers. Potential routes of exposure to sediment would include ingestion and dermal contact. Potential routes of exposure to stormwater would include ingestion, dermal contact, and inhalation of vapors.

Off-site workers who perform construction that extends into the groundwater could be exposed to constituents in shallow groundwater, in areas where the groundwater is within typical excavation depths. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor.

Recreational Waders

Recreational waders could be exposed to surface water and sediments in Morses Creek in the section downstream of the Linden Avenue municipal storm sewer outfall, which discharges stormwater contributions from the Facility. Potential exposure of recreational waders is possible only in limited areas that are reasonably accessible because much of Morses Creek in the vicinity of the Facility is fenced, or runs in underground culverts. Potential exposure to sediment would include incidental ingestion and dermal contact. Potential exposure to surface water would include incidental ingestion, dermal contact, and inhalation of vapors.

D. Estimation of Exposure Concentrations

This section discusses the estimation of exposure concentrations for the media to which receptors could be exposed in the exposure scenarios summarized in the conceptual site model (Table 5.1). Section 5.04.D.1 discusses the calculation of exposure concentrations in soil and smear zone soil. The calculation of exposure concentrations in groundwater, sediment, surface water, and LNAPL is discussed in Section 5.04.D.2.

1. Soil

Reasonable maximum exposures (RME) are conservatively estimated in this risk assessment by using the maximum detected concentrations at each area for most constituents and the 95% upper confidence limits (UCLs) on the mean for certain constituents, if sufficient data are available. In this approach, maximum concentrations are first used to calculate bounding estimates of cumulative cancer and noncancer risks. If these bounding estimates of RME risks do not exceed EPA's cumulative cancer and noncancer risk triggers for corrective measures (i.e., cumulative site-related cancer risk of 10^{-4} and noncancer hazard index (HI) of 1), then further calculations are not necessary.

If a bounding estimate exceeds a trigger for corrective measures, then the bounding estimate is refined by replacing the maximum concentrations that contributed the most to the bounding estimate with 95% UCLs. Experience with this approach at many facilities shows that cumulative cancer and noncancer risk estimates are often influenced by only a few constituents. This means the computation of 95% UCLs, which can be time-consuming, is usually necessary for only a few constituents.

The use of maximum concentrations for many constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to many constituents constantly, when the RME generally would not have so many constituents at worst-case concentrations at all times. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.06.D.

The 95% UCL for a constituent is calculated using the nonparametric bootstrap method known as the bias-corrected and accelerated (BCa) method with 4,000 bootstrap replications (Efron and Tibshirani 1998). A nonparametric bootstrap confidence interval does not rely on assumptions about the data's underlying probability distribution which are often difficult to confirm, but instead are based on statistical re-sampling of the empirical distribution of the observed concentrations. For an empirical distribution that is approximately normal, the bootstrap confidence interval will be essentially the same as the normal confidence interval. For an empirical distribution that is not normal, however, the bootstrap confidence interval will be more accurate than a confidence interval calculated assuming a normal (or even lognormal) distribution (USEPA 1997c).

The constituents selected for 95% UCL calculations are those with maximum concentrations that contribute the most to the initial bounding estimates of the RME cumulative risks, if these data sets have at least eight data points. Using 95% UCLs for these constituents and maximum concentrations for other constituents still overestimates the RME cumulative risks, but is an efficient approach that avoids 95% UCL calculations that would not materially affect cumulative risk estimates, and is consistent with USEPA guidance (1989; p 6-25). UCLs were not calculated for data sets with less than eight data points, because nonparametric BCa bootstrap UCLs might be less reliable for these smaller data sets.

As noted in Section 5.04.C.2, off-site workers at unpaved off-site areas along portions of the Facility's western and eastern boundaries could be exposed to certain constituents that have potentially significant concentrations in on-site soil. The actual significance of these potential off-site exposures is conservatively evaluated using risk estimates for exposure of on-site workers to soil along these portions of the Facility boundaries. At the western Facility boundary, exposure concentrations are based on the exposure concentrations for evaluating exposure of routine workers at AOI 29. At the eastern Facility boundary, exposure concentrations are based on soil characterization data

collected on-site within 100 ft of the Facility fence line, which are expected to best represent off-site exposure concentrations along the fence line. This area is referred to as the "Eastern Boundary Area" in the rest of this report.

Smear zone soil concentrations at AOI 6 are conservatively estimated in this risk assessment by assuming that soil in the smear zone is 100% saturated with LNAPL, as discussed in Appendix M. This approach is used because soil sampling in the LNAPL area at AOI 6 did not specifically target the depth interval in which the LNAPL layer fluctuates with the water table (i.e., the smear zone).

2. Other Media

Exposure concentrations for groundwater, sediment, surface water, and LNAPL are conservatively estimated using the highest detected concentrations in these media.

The highest detected concentrations of PAHs in sediment from the Facility's on-site storm sewers are used to evaluate potential exposure of on- and off-site workers who might be exposed during maintenance or repair of storm sewers, as well potential exposure of recreational waders in Morses Creek, since PAH data were not collected from off-site storm sewers or from Morses Creek. Similarly, lead concentrations in sediment and surface water from on-site storm sewers are used to evaluate potential exposure of off-site workers who might be exposed during maintenance or repair of off-site storm sewers. Potential exposure of recreational waders to lead in sediment and surface water in Morses Creek is evaluated directly using lead data for these media collected from Morses Creek during the RFI.

3. Fate and Transport Models

The following models are used to estimate exposure concentrations for the exposure scenarios discussed in Section 5.04.C. These models are used by USEPA and state regulatory agencies for screening-level analysis. The following are brief descriptions of the models. Further details of these models are provided in Appendix M.

Vapor Intrusion into Buildings

Indoor air concentrations that might result from migration of vapors from soil or groundwater into a building are estimated using the model described by Johnson and Ettinger (1991), which USEPA recommends for screening-level evaluations (USEPA 2003a). The calculations in this risk assessment are based on hypothetical

commercial/industrial buildings and hypothetical residential buildings, rather than actual on-site and off-site buildings. The characteristics of the hypothetical buildings are modeled using conservative assumptions from regulatory guidance for these building types. Site-specific data for soil properties collected during the RFI are also used in the calculations. A discussion of the model and the input parameters used in the assessment is provided in Appendix M.

Vapor Emission from Exposed Groundwater

The model for estimating vapor emissions from exposed groundwater in an open excavation pit that extends into the water table is based on mass-transfer coefficients recommended in USEPA guidance (USEPA 1995c).

Vapor Emission from Exposed LNAPL

Vapor emissions from exposed LNAPL in an open excavation pit that extends into LNAPL are estimated using the "oil film surface emission model" recommended in USEPA guidance (USEPA 1987).

Air Dispersion

Air concentrations are estimated using USEPA's SCREEN3 air dispersion model (USEPA 1995a). The area-source algorithm in SCREEN3 is used with default and region-specific meteorological parameters to estimate maximum 1-hour concentrations at ground level. Source areas are estimated as square sources.

For the construction worker scenario, the maximum 1-hour air concentrations are converted to maximum 24-hour average air concentrations using a conservative factor of 0.4. The air concentrations estimated in this approach are conservative (i.e., expected to predict higher than actual air concentrations to which receptors would be exposed).

Uncertainties inherent in the models and assumptions used in estimating exposure concentrations are discussed in Section 5.06. D.2.

E. Estimation of Intakes

The exposure factors for evaluating the exposure scenarios summarized in the CSM and discussed in Section 5.04.C are discussed in this section. In this risk assessment, standard default exposure factors recommended by USEPA for estimating reasonable

maximum exposures are used where available and appropriate. Where standard default exposure factors are not available or not appropriate for an exposure scenario, the evaluation is conducted using similarly conservative exposure factors that are based on site-specific considerations and professional judgment.

1. Routine Workers

In this risk assessment, potential exposure of routine workers to soil is conservatively evaluated using the exposure factors that USEPA Region 9 used in deriving its PRGs (2002). These exposure factors are standard default exposure factors recommend by USEPA (1991a) for estimating RME, except Region 9 used a soil ingestion rate of 100 mg/day which is twice the standard default rate of 50 mg/day. According to USEPA, the standard default exposure factors are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are intended to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of a potentially exposed population.

Although it is recognized that the use of these exposure factors, rather than site-specific factors, results in overestimation of RME risks at the Facility, this approach streamlines the risk assessment by allowing risk estimates to be calculated very efficiently from the PRGs. The evaluation is also streamlined because the added conservatism in the PRG-based risk estimates allows them to be used as conservative estimates for other receptors. In this risk assessment, the risk estimates for routine workers are used to evaluate potential exposures of construction workers and trespassers to soil, because the exposure to these receptors are expected to be lower than those assumed in the PRGs (ENVIRON 2003).

2. Construction Workers

Potential exposure of construction workers to soil is evaluated using the risk estimates for routine workers for all AOIs except AOIs 3, 6, 7, 11, 20, and 29, as discussed in Section 5.04.E.1. The exposure factors used for evaluating potential exposure of construction workers to soil at AOIs 3, 6, 7, 11, 20, and 29, smear zone soil, sediment, groundwater, and LNAPL are as follows:

Soil Ingestion Rate

A soil ingestion rate of 200 mg/day is used for workers performing maintenance work that involves excavation into the soil. This rate is lower than the 480 mg/day that is often cited as USEPA's recommended soil ingestion rate for excavation or construction

scenarios (USEPA 1991a). However, the 480 mg/day rate is based on an assumption regarding soil adherence to hands that has been shown in USEPA-funded field studies to overestimate (by 3 to 4-fold) soil adherence to hands during various excavation and construction activities. Replacing the earlier soil adherence assumption with soil adherence data from the USEPA-funded studies (USEPA 1997b) would give a soil ingestion rate of approximately 120 mg/kg to 160 mg/kg. Therefore, using a rate of 200 mg/kg is conservative.

Sediment Ingestion Rate

The sediment ingestion rate of 50 mg/day is 50% of the USEPA-recommended soil ingestion rate of 100 mg/day for evaluating high-end exposure of adults (USEPA 1991a), based on professional judgment that simultaneous contact with surface water in this scenario would tend to wash sediment off hands and thereby reduce incidental sediment ingestion during hand-to-mouth contact.

Soil and Sediment Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin area of 3,300 cm² and the soil-to-skin adherence factor of 0.2 mg/cm² are the USEPA-recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings (USEPA 2001). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA 2001). The same contact rate and absorption assumptions are used for evaluating dermal exposure to sediments.

Groundwater Ingestion Rate

A rate of 0.005 L/hour is used for incidental ingestion of groundwater during construction work in excavations that extend into groundwater. This rate is 10% of the rate that USEPA (1989) recommends for ingestion while swimming, and represents a very conservative estimate of incidental groundwater ingestion that could occur while workers are in an excavation pit.

Groundwater and LNAPL Dermal Contact Rates

The exposed skin surface area is the same as that discussed above for exposure to soil and sediment. Workers are conservatively assumed to be covered with groundwater or LNAPL over this exposed skin surface area for 2 hours per event. The absorbed dose for organic chemicals is estimated using a nonsteady-state approach (USEPA 2001), which is more conservative than the steady-state approach (USEPA 1989), particularly for hydrophobic chemicals. The permeability coefficients (K_p) for dermal absorption from groundwater and LNAPL are estimated following USEPA guidance (1992, 2001).

Exposure Frequency and Duration

The number of days of construction/maintenance activities is assumed to be 50 days, which is assumed to occur at a frequency of 5 days/year for a period of 10 years. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that workers are actually in contact with soil, groundwater and LNAPL (as opposed to the total time for maintenance or construction, which typically includes time not associated with excavation). This combination of exposure frequency and exposure duration is also expected to be conservative for the amount of time that workers may spend maintaining or repairing stormsewers, since such utilities do not generally require periodic cleaning or maintenance. The assumption of 5 days/year can represent the time for a few small repairs per year or one larger repair. The duration of 10 years is more than twice the length of time that workers typically work at one location (USEPA 1997b).

Body Weight

The body weight of 70 kg is the standard USEPA-recommended body weight for assessing exposure to adults (USEPA 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989).

3. Residents

The exposure factors for evaluating potential inhalation exposure of residents via vapor intrusion are as follows.

Exposure Frequency

An exposure frequency of 350 days per year is used for evaluating high-end residential exposure of children and adults (USEPA 1991a). This exposure frequency assumes daily exposure at the residence, except for two weeks per year away from home (e.g., while on vacation).

Exposure Duration

The exposure duration is 30 years and is based on the USEPA-recommended exposure duration for evaluating high-end residential exposures (USEPA 1991a). It is the 95th percentile number of years residents live at one location.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989).

4. Recreational Waders in Morses Creek

The exposure factors for evaluating potential exposure of recreational waders to sediments in Morses Creek are as follows.

Sediment Ingestion Rate

The sediment ingestion rate of 100 mg/day and 50 mg/day is used for evaluating high-end exposure of children and adults, respectively. These sediment ingestion rates are 50% of the USEPA-recommended soil ingestion rate of 200 mg/day and 100 mg/day for children and adults, respectively (USEPA 1991a), based on professional judgment that simultaneous contact with surface water in this scenario would tend to wash sediment off hands and thereby reduce incidental sediment ingestion during hand-to-mouth contact.

Sediment Dermal Contact Rate and Absorption

The exposed skin surface area for children and adults are 3,520 cm² and 9,000 cm², respectively. These areas are based on exposed skin

on the arms, legs and hands while wading in the Creek. The sediment adherence factor is the same as that recommended in USEPA guidance for soil, i.e., 0.2 and 0.07 for children and adults, respectively (USEPA 2001). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA 2001).

Exposure Frequency and Duration

For evaluating potential exposures to sediment in readily accessible segments of Morses Creek, an exposure frequency of 24 days/year is assumed. This frequency assumes that visits to Morses Creek occur 2 days/week for three months when the average daily temperature is above 70 degrees F based on air temperature data for Newark, New Jersey (NOAA 2000). The exposure duration for the age-adjusted resident is 6 years and 24 years for the child and adult (USEPA 1999). This exposure duration is the 95th percentile number of years residents live at one location (USEPA 1991a).

Body Weight

The body weights of 70 kg and 15 kg are the standard USEPA-recommended body weights for assessing exposure to adults and children, respectively (USEPA 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989).

Uncertainties associated with the exposure factors used in estimating chemical intakes are discussed in Section 5.06.D.

5.05 Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals, and determines the dose-response relationship between exposure and the occurrence of adverse effects. Toxicity information used in the risk assessment is derived from two categories of sources. The toxicity values that USEPA Region 9 used in developing its PRGs are implicitly used in cancer and noncancer risk estimates that are derived using the

PRGs. The toxicity values used in deriving site-specific soil and groundwater screening criteria, and the associated estimates of cumulative cancer and noncancer risks, were compiled from the following USEPA hierarchy of sources (USEPA 2003c):

1. Integrated Risk Information System (IRIS)
2. Provisional Peer Reviewed Toxicity Values (PPRTV)
3. Other

When a toxicity value was not available from the first two tiers of sources, other USEPA sources of toxicity values were consulted. The toxicity values used in the risk assessment and their sources are summarized in Appendix M, and are discussed below.

A. Toxicity Values for Carcinogens

USEPA considers chemicals belonging to the following USEPA cancer weight-of-evidence groups as human carcinogens:

- | | |
|----------|--|
| Group A | Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans |
| Group B1 | Probable Human Carcinogen: Limited evidence of carcinogenicity in humans |
| Group B2 | Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans |
| Group C | Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans |

As shown in Appendix M, USEPA has designated some of the constituents as Group B2 or Group C, which means that USEPA acknowledges that there is either inadequate or a lack of evidence that these constituents actually cause cancer in humans. Therefore, evaluating these constituents as human carcinogens in the risk assessment is highly conservative.

USEPA-derived cancer slope factors (SFs) and inhalation unit risk factors (URFs) for these constituents and their sources are shown in Appendix M. The oral SFs and URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose. As recognized by USEPA, there is significant scientific evidence that some of the SFs and URFs may be overly conservative and may ignore the potential existence of threshold doses. Nonetheless, they are used here as conservative assessment tools.

B. Toxicity Values for Noncarcinogens

Constituents designated by USEPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Constituents not designated as belonging to any cancer group are treated as noncarcinogens. USEPA-derived chronic reference doses (RfDs) and chronic inhalation reference concentrations (RfCs) for these constituents and their sources are shown in Appendix M.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects during a lifetime. These RfDs and RfCs typically incorporate several safety factors to account for uncertainties in their derivation, which in combination often result in overall uncertainty factors of 1,000 or more. Furthermore, for many constituents, there is significant scientific debate about the validity of these RfDs and RfCs, and the association of these doses and concentrations to potential adverse health consequences. Nonetheless, the RfDs and RfCs are used here as conservative assessment tools.

C. Extrapolation of Toxicity Values

The USEPA sources of toxicity values do not provide dermal toxicity values for any of the constituents. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values are made in this route-to-route extrapolation based on USEPA guidance (USEPA 2001).

The USEPA sources of toxicity values do not provide inhalation toxicity values (URFs and RfCs) for all of the constituents. For a constituent that has no inhalation toxicity value, the oral SF and/or RfD, if available, is converted to an URF and/or RfC using default USEPA assumptions (USEPA 1997a).

Uncertainties introduced by using extrapolated toxicity values are discussed in Section 5.06.D.

5.06 Risk Characterization

The health significance of the potential exposures identified in Section 5.04 is discussed in the following subsections. Section 5.06.A describes the methods for quantifying cancer risks and noncancer hazard indices. Section 5.06.B discusses the risk estimates and the significance of the potential exposures associated with chemicals other than lead. Section 5.06.C discusses

the significance of potential exposures to lead. Uncertainties in the risk evaluation are discussed in Section 5.06.D.

A. Cancer Risk and Noncancer Hazard Index

The cancer risk associated with potential exposure to a carcinogenic chemical is calculated by multiplying an estimate of the lifetime average daily dose (LADD) for a particular exposure scenario by the cancer slope factor (SF) for the chemical, as follows:

$$Risk = LADD \cdot SF$$

For the inhalation route, the inhalation cancer risk is calculated using the chemical concentration in air (C_{air}) and the URF, as follows:

$$Risk = C_{air} \cdot URF \cdot \frac{EF \cdot ED}{AT}$$

where EF is exposure frequency, ED is exposure duration, and AT is averaging time. The noncancer hazard quotient (HQ) associated with potential exposure to a noncarcinogenic chemical is calculated by dividing an estimate of the average daily dose (ADD) for a particular exposure scenario by the reference dose (RfD) for the chemical, as follows:

$$HQ = \frac{ADD}{RfD}$$

For the inhalation route, the inhalation HQ is calculated using C_{air} and the RfC, as follows:

$$HQ = \frac{C_{air}}{RfC} \cdot \frac{EF \cdot ED}{AT}$$

The potential cancer risk and noncancer effects that may result from exposure to the combination of constituents at an area are estimated following USEPA guidance (1989), as follows:

$$Cumulative Risk = \sum_i Risk_i$$

$$Hazard Index = \sum_i HQ_i$$

where:

- $Risk_i$ = estimated cancer risk for the i th constituent
 HQ_i = hazard quotient for the i th constituent

This approach may result in estimates of cumulative cancer and noncancer risks that are more conservative than necessary. For example, different chemicals may cause different and unrelated health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effect. As such, estimates based on this approach are further evaluated where necessary (e.g., by segregating HIs by target organs and/or mode of action). Uncertainties associated with this approach are discussed in Section 5.06.D.

The cumulative cancer risk and HI estimates for each receptor population are compared with USEPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively, for determining whether corrective measures are warranted for a particular area of the Facility (61 FR 19432, May 1, 1996; USEPA 1991b). The risk estimates and results of the comparison to the USEPA-established limits are discussed in the following sections.

B. Risk Estimates for Potentially Exposed Populations

1. Routine Workers

The significance of risks associated with potential exposure of on-site and off-site routine workers to soil via direct contact (incidental ingestion, dermal contact, and inhalation), and to soil and groundwater via vapor intrusion is discussed below.

Potential exposure of routine workers to exposed outdoor soil was first evaluated using bounding estimates of RME cumulative cancer and noncancer risks to streamline the risk evaluation, as explained in Section 5.04.D. The initial estimates were calculated using maximum site-related concentrations for all constituents detected in soil at an area and the USEPA Region 9 PRGs (2002). These estimates are considered bounding estimates because the RME risks for an area would be lower if concentrations representative of the area were used instead of maximum concentrations, and if site-specific exposure factors were used to account for the magnitude, frequency, and duration of exposures appropriate for the area.

The bounding estimates of site-related cumulative cancer and noncancer risks were compared to USEPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively. For an area where the bounding estimate of cancer risk or HI was higher than the USEPA limits, further calculations were conducted using 95% UCLs for certain constituents, as explained in Section 5.04.D.

The bounding estimates of site-related cumulative cancer risk and HI for potential exposure of routine workers to exposed outdoor soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 5.2. The table shows that the risk estimates for the following areas investigated during the RFI do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1:

- AOI 8 - Former Powerhouse Heating Oil ASTs
- AOI 10 - Former Storage Shed
- AOI 16 - Former Petroleum USTs
- AOI 17 - Company Car Fuel Point
- AOI 21 - Waste Thinner Handling Area/Powerhouse
- AOI 22 - Railroad Wells Within Building Interior
- AOI 23 - Former Interior Testing Pits
- AOI 25 - Former Drum Storage Area
- AOI 26 - Abandoned UST
- AOI 27 - Stained Asphalt Area
- AOI 28 - Southern Boundary Area
- General (soil samples collected during site-wide groundwater investigations)
- Eastern Boundary Area

The highest cumulative cancer risk estimate for these areas is 1×10^{-4} and many are 10^{-5} or lower. The highest HI estimate is 1 and many are 0.2 or lower. As discussed in Section 5.04.D.1, the risk estimates for the Eastern Boundary Area are for potential exposure of off-site routine workers at the industrial property along the Facility's eastern boundary.

As shown in Table 5.2, the bounding estimates of cumulative cancer risk and HI exceed the cancer risk limit and/or the HI limit for the following areas:

- AOI 3 - Existing Drum Storage Area/Fill Area
- AOI 6 - Paint Mix Building
- AOI 7 - Former Bulk Fluids AST Farm
- AOI 11 - Former Reclamation Area
- AOI 20 - Bone Yard
- AOI 29 - MW 18 Area

As discussed in Section 5.04.D.1, the risk estimates for AOI 29 are for potential exposure of both on-site routine workers and off-site routine workers at the industrial property along the Facility's western boundary.

The risk estimates for these six AOIs were refined by evaluating the significance of potential exposure to constituents in shallow soil (i.e., 0 to 2 ft bgs), which is the depth interval that routine workers are expected to encounter in unpaved areas. These estimates of cumulative cancer risk and HI were also refined by using the maximum concentrations in shallow soil and the 95% UCLs for the constituents in shallow soil that contributed greatest to the bounding estimates of risks. The constituents that were selected for calculation of 95% UCLs and the risk calculations for these areas are shown in Appendix M. The risk estimates for all the AOIs are summarized on Table 5.3, which show that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1; except the HI estimate for AOI 3 exceeds 1.

For AOI 3, the estimated HI is 2, and is primarily due to summing the HQs for chromium and manganese, which are 0.6 and 0.8, respectively. However, summing the HQs for these constituents is unnecessarily conservative because the target organ and mechanisms of action for the effects expected from oral exposure to chromium (assumed to be hexavalent in these calculations) are not expected to be similar to those from oral exposure to manganese. According to the ATSDR (2000), gastrointestinal and hematological effects are the only effects that have been reported for chronic ingestion of hexavalent chromium at doses higher than the dose that provided the basis for the oral RfD. In contrast, the oral RfD for manganese is based on central nervous system effects. When the HQs for chromium and manganese are segregated on this basis, the estimated HIs for AOI 3 do not exceed 1, as shown in the calculations included in Appendix M. Additional discussion of the conservatism in the HQs for chromium and manganese is included in Section 5.06.D.

The significance of potential exposure of routine workers to constituents in soil and groundwater via assumed vapor intrusion is evaluated by dividing the highest concentrations of constituents in soil and groundwater by their corresponding vapor intrusion criteria, and then summing the resulting ratios. These ratio sums are not estimates of cumulative cancer risk or HI, but are estimates of "equivalent exposure" to chemical mixtures in air as described in 29 CFR 1910.1000(d)(2)(i) for assessing compliance with occupational exposure limits, which is further discussed in Appendix M. The significance of assumed on-site vapor intrusion exposures is assessed using these regulations because these regulations are applicable to the Facility. The results of a sensitivity analysis based on URFs and RfCs is discussed in Section 5.06.D.4.

These ratio sums are shown on Table 5.4 and Table 5.5 for soil (including LNAPL at AOI 6) and groundwater, respectively. As shown on these tables, the ratio sums for soil and groundwater are all much less than 1. The highest sum is 0.03 for soil at AOI 6 (due primarily to benzene in soil), and the rest of the sums are no higher than 0.005. These sums show that the conservatively assumed contributions to indoor air from vapor intrusion would represent an insignificant fraction of the allowable occupational exposure limit for chemical mixtures in air. The vapor intrusion criteria used in these calculations are those discussed in Section 4.01 and Section 4.02, respectively. Details of the vapor intrusion modeling calculations and the derivation of these criteria are provided in Appendix M.

2. Construction Workers

The significance of risks associated with potential exposure of construction workers to soil and groundwater, LNAPL at AOI 6, and sediments in storm sewers is discussed below.

Soil

Potential exposure of construction workers to soil is evaluated indirectly using exposure estimates for routine workers for all AOIs except AOIs 3, 6, 7, 11, 20, and 29, as explained in Section 5.04.C. This streamlines the risk assessment and is conservative because construction worker exposures for occasional excavations would be lower than routine worker exposures. Therefore, the risk and HI estimates for construction workers are expected to be no higher than the estimates for routine workers discussed in Section 5.06.B.1 and summarized in Table 5.2, which shows that the estimates do not exceed the cancer risk limit of 10^{-4} and the HI limit 1, except at AOIs 3, 6, 7, 11, 20, and 29.

At AOIs 3, 6, 7, 11, 20, and 29, potential exposure of construction workers is directly evaluated using exposure assumptions specific to construction workers. As shown on Table 5.6, the estimates for these areas do not exceed the cancer risk limit of 10^{-4} and the HI limit 1. The calculations for the risk estimates based on construction worker exposure assumptions are shown in Appendix M. Because these calculations became necessary for these six AOIs, they were also performed for the other areas with only little additional effort to verify that risk estimates specific to the construction scenario are in fact much lower than those shown on Table 5.2. The risk estimates for these areas are also shown on Table 5.6.

Groundwater

Estimates of risks for potential exposure of construction workers to shallow groundwater are calculated in Appendix M. The highest detected constituent concentrations in groundwater are used as the exposure concentrations for all areas. The estimates of cumulative cancer risk and HI for potential exposure of construction workers to shallow groundwater are summarized in Table 5.7, which shows that all areas have estimates that do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1. The highest cumulative cancer risk estimate is 10^{-6} and the highest HI estimate is 0.08.

Table 5.7 also includes the risk estimates for exposure of construction workers to groundwater underlying the LNAPL at AOI 6. These estimates are conservatively based on the concentrations detected in the water sample collected from under the LNAPL, which likely include contributions from NAPL in addition to the dissolved-phase. The estimates of cumulative cancer risk and HI are 1×10^{-6} and 0.08, respectively.

LNAPL and Smear Zone Soil

Bounding estimates of cumulative cancer risks and HIs are calculated for potential exposure of construction workers during excavations at AOI 6 that encounter LNAPLs and/or smear zone soil. The calculations are provided in Appendix M. These estimates are summarized on Table 5.8, which shows that the estimates of cumulative cancer risk and HI for potential exposure to smear zone soil do not exceed the limits of 10^{-4} and 1, respectively. However, the estimates of cancer and noncancer risks for potential exposure via inhalation of vapors from the LNAPL exceed USEPA's acceptable limits. The high estimates are primarily due to the concentrations of TCE, xylenes, cis-1,2-DCE, and benzene in the LNAPL.

The estimates of risks shown on Table 5.8 conservatively assume that construction workers do not wear any personal protective equipment during excavations. However, current construction activities at this AOI (and throughout the Facility) are covered by the Facility's health and safety procedures, so that no significant exposure is actually occurring.

Sediment in Storm Sewers

Estimates of risks for potential exposure of construction workers to sediment in the storm sewers are calculated in Appendix M. The highest detected constituent concentrations in storm sewer sediment are used as the exposure concentrations. The estimates of cumulative cancer risk and HI for potential exposure of construction workers to sediment in the storm sewers are summarized in Table 5.9, which shows that the estimates do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

No constituent except lead was detected in the storm water samples collected from the on-site storm sewers, as noted in Section 4.16. Therefore, the calculation of cancer and noncancer risk estimates for potential exposure of construction workers to storm sewer water is unnecessary. The significance of potential exposure to lead is discussed in Section 5.06.C.

3. **Trespassers**
Currently, the Facility is completely paved, except in two small areas that are landscaped, therefore there are no current exposures of trespassers to surface or subsurface soil. However, potential exposure of trespassers to soil in the future is evaluated indirectly using exposure estimates for routine workers, as explained in Section 5.04.C. This streamlines the risk assessment and is conservative because trespasser exposures would be lower than routine worker exposures. Therefore, the risk and HI estimates for trespassers are expected to be no higher than the estimates discussed in Section 5.06.B.1 and summarized in Tables 5.2 and 5.3, which show that the estimates do not exceed the cancer risk limit of 10^{-4} and the HI limit 1.
4. **Off-Site Residents**
The significance of potential exposure of off-site residents to constituents in groundwater via assumed vapor intrusion is evaluated by using the vapor intrusion modeling calculations provided in Appendix M. Bounding estimates of cumulative cancer risk and HI are calculated using maximum concentrations of all constituents detected at the most downgradient on-site monitoring wells at the Facility that are screened in the shallow overburden. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 5.10, which shows that they do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

5. Recreational Waders in Morses Creek

Estimates of risks for potential exposure of recreational waders to sediment in Morses Creek are calculated in Appendix M. The highest detected constituent concentrations in sediment from the on-site storm sewers that discharge to Morses Creek are conservatively used as exposure concentrations. The estimates of cumulative cancer risk and HI for potential exposure of recreational waders to sediment in Morses Creek are summarized in Table 5.11, which shows that the estimates do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

As noted in Section 4.16, no constituent except lead was detected in the storm water samples collected from the on-site storm sewers that discharge to Morses Creek. Therefore, the calculation of cancer and noncancer risk estimates for potential exposure of recreational waders to surface water in Morses Creek is unnecessary. The significance of potential exposure to lead is discussed in Section 5.06.C.

C. Exposures to Lead

USEPA has not developed a cancer slope factor or a reference dose for lead. Therefore, risks from exposures to lead are not expressed in terms of cancer risks or noncancer HQs. The significance of potential exposures to lead in soil/sediment and in stormwater/surface water is discussed in Section 5.06.C.1 and Section 5.06.C.2, respectively.

1. Soil and Sediment

USEPA evaluates the risk from exposure to lead in soil using blood lead level as an index of exposure. Using a blood lead model, USEPA has established a conservative soil screening level of 400 mg/kg that is protective of residential exposure to lead in soil. USEPA has also recommended a blood lead modeling methodology for deriving criteria that are protective of routine worker exposure to lead in soil (USEPA 2003). Criteria derived using this methodology can range from approximately 750 mg/kg to 1,750 mg/kg, with an average of approximately 1,000 mg/kg.

In this risk assessment, the USEPA-recommended methodology for deriving criteria for routine workers was adapted to derive criteria for construction workers. The criteria for construction workers were derived by replacing the soil ingestion rate, exposure frequency, and exposure duration for routine workers with those for construction workers, which are discussed in Section 5.04.E.2. The resulting criteria range from approximately 8,200 mg/kg to

19,000 mg/kg, with an average of approximately 13,000 mg/kg. Derivation of these criteria is included in Appendix M.

As discussed in a recent rulemaking, soil lead screening criteria should be compared with the arithmetic mean concentration of lead within the area where potential exposures are assumed to occur, to be consistent with the principles underlying the blood lead modeling approaches used to derive the screening levels. The mean lead concentrations in soil and sediment at the areas investigated during the RFI are summarized on Table 5.12, and Table 5.13, respectively.

Comparison of the mean lead concentrations with the relevant criteria shows that no area has significant lead concentrations, except at AOIs 10 and 11 where the mean soil lead concentrations in surface soil (0 to 2 ft bgs) are approximately 5,000 mg/kg which is higher than the criterion for routine workers. However, AOIs 10 and 11 are currently paved so that no exposure of routine workers to surface soil is actually occurring at these areas. Also, as discussed in Section 4.11.B, the presence of lead over a relatively large area on the eastern side of the Facility could be related to historical placement of fill material during initial development of the site, rather than due to a release from the Facility's operations. The high lead concentrations in the fill material, however, do not appear to extend off-site, since the mean soil lead concentration in the East Boundary Area are much lower (approximately 700 mg/kg), and are below the range of criterion for protection of routine workers.

2. Stormwater and Surface Water

The significance of exposure to lead in stormwater and surface water are conservatively evaluated in this risk assessment by comparing the concentrations of lead in these media with the drinking water standard for lead of 0.015 mg/L. This approach is highly conservative because exposure to lead in these media is much lower than exposure via drinking water consumption. However, this comparison is useful because the results can be easily interpreted to show that potential exposures to lead in stormwater and surface water would not be significant.

The highest concentration of lead in stormwater samples collected during the RFI from the on-site storm sewers is 0.1 mg/L. This concentration is approximately 10 times higher than the MCL. However, the exposure of construction workers in this scenario is more than 1,000 times lower than exposure via drinking water. Therefore, potential exposure of constructions

workers to the concentrations of lead in stormwater in the on-site sewers is not significant.

The highest concentration of lead in surface water samples collected during the RFI from Morses Creek is 0.003 mg/L. This concentration is lower than the MCL. Therefore, potential exposure of recreational waders to lead in surface water in Morses Creek is not significant.

D. Uncertainty Analysis

1. Exposure Concentrations

As discussed in Section 5.04.D, most exposure concentrations for soil in this risk assessment are based on the highest concentrations detected in soil at each area, and 95% UCLs are calculated only when a bounding estimate of the RME cumulative cancer risk or HI exceeds the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. This approach streamlines the risk assessment by avoiding calculation of 95% UCLs that would not materially affect risk assessment conclusions regarding the need for corrective measures.

However, this approach inflates the cumulative cancer risk and HI estimates that do not exceed 10^{-4} and 1, respectively, since these estimates are entirely based on maximum concentrations. As explained in Section 5.04.D, the use of maximum concentrations for all constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to all constituents constantly, when the RME generally would not have all constituents at worst-case concentrations at all times. The inflation of these risk and HI estimates makes them closer to the cumulative cancer risk limit of 10^{-4} and the HI limit of 1 than they would be if 95% UCLs were used.

As noted in Section 5.04.D.1, UCLs were calculated only if at least eight data points were available because nonparametric BCa bootstrap UCLs might be less reliable for smaller data sets. In the case of chromium and manganese in soil at AOI 3, the HQs were conservatively based on the highest detected concentrations in shallow soil (at MW-21S from 1 to 1.5 ft bgs) because each of these constituents had six data points instead of eight. This gave an HI of 2, which is high-biased. If 95% UCLs for these constituents in surface soil were used (chromium of 798 mg/kg and manganese of 8,020 mg/kg), the HI would have been 0.9.

The above discussion regarding soil exposure concentrations also applies to groundwater exposure concentrations for the excavation scenario, since construction workers would not be expected to contact groundwater with the maximum concentrations of every constituent during every on- and off-site excavation.

For the groundwater vapor intrusion scenarios, the use of maximum concentrations also overstates the RME risk. This is because the groundwater under an individual on-site or off-site building is unlikely to have the maximum concentrations of all constituents. However, these bounding estimates can be useful for identifying constituents for which significant risk is possible, so that risk-based concentration limits for such constituents can be used to identify specific locations where significant exposures might occur.

Most exposure concentrations that are based on mathematical modeling of constituent transfer from soil or groundwater to air are conservative for the same reasons discussed above, since the model estimates are based on the use of maximum concentrations in soil or groundwater. In addition, the model estimates are conservative because they generally do not account for the reduction of constituent concentrations in the soil or groundwater as constituent transfer from these media. As a result, risk estimates that are based on the sum of risk estimates for multiple media are more conservative than necessary for RME estimates. These include almost all the risk estimates discussed in Section 5.06.

Another factor that inflated some exposure concentrations and their associated estimates of site-related cancer and noncancer risks is the assumption that all concentrations are site-related. As noted in Section 5.02.B, the concentrations of all organic and inorganic chemicals were assumed to be site-related in this risk assessment because the RFI field investigation did not attempt to quantify site-specific background levels (i.e., levels not associated with a release from the Facility). However, as discussed in Section 4 and earlier in Section 5, the concentrations of several organic and inorganic chemicals in soil and groundwater appear to be unrelated to any release from the Facility's operations.

Specifically, the presence of potentially significant concentrations of PAHs and lead in soil across large parts of the Facility appear related to fill material that was placed during initial development of the site and construction of the Facility, rather than to a release associated with Facility operations. In addition, several chemicals with potentially significant concentrations in

groundwater from the deeper saturated zones were never detected in shallower groundwater or any soil samples collected during the RFI, and are not known to have been used in the Facility's operations. However, the risk assessment conservatively evaluated these concentrations as though they are site-related.

The risk assessment also did not attempt to account for natural background levels of metals in soil by using information from the scientific literature or from NJDEP guidance. However, this approach did not substantively affect the risk assessment conclusions. For example, NJDEP guidance provides a background level of 20 mg/kg for arsenic in soil, which represents a cancer risk and HQ of approximately 10^{-5} and 0.08, respectively, for routine worker exposures, based on the calculations used in this risk assessment. Counting these background contributions as site-related did not materially add to the cumulative cancer risk and HI estimates, and did not affect conclusions drawn from comparison of these estimates to the USEPA-established triggers for initiating corrective measures (i.e., cumulative cancer risk of 10^{-4} and HI of 1).

2. Exposure Factors

As discussed in Section 5.04.E, most of the exposure factors used in the risk assessment are high-end (i.e., 90th to 95th percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90th percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual, particularly when such exposure factors are combined with exposure concentrations that are based on maximum concentrations.

Also, the use of generic default exposure factors for evaluation of potential exposure of workers to soil is more conservative than necessary for RME estimates, which allow the use of site-specific considerations (USEPA 1989). For example, the "fraction contacted" terms used in this evaluation assume that routine workers are exposed to soil for an entire work day at each area, but workers at commercial/industrial sites generally spend only a part of the work day at a particular part of the Facility.

As noted in Section 5.04.E.1, the ingestion rate used for estimating exposure of routine workers to soil is twice the USEPA-recommended standard default value of 50 mg/day. Therefore, the risk estimates for this scenario are more conservative than necessary, particularly for constituents with risk estimates

that are dominated by the ingestion route (e.g., most SVOCs, PCBs, and metals).

The ingestion rate for estimating exposure of construction workers to soil in this risk assessment is 200 mg/day. As noted in Section 5.04.E.2, this ingestion rate is based on USEPA-compiled soil-to-hand adherence data for construction-related activities (USEPA 1997), and is believed to be plausible, conservative, and consistent with the expectation that incidental soil ingestion is associated primarily with hand-to-mouth contact. More recently, USEPA guidance (2003) recommends an ingestion rate of 330 mg/day that is based on the variability in the data from a single soil ingestion study that involved a small number of individuals. This ingestion rate was not used in the risk calculations discussed in Section 5.06.2 because it is based on very limited data that might not be appropriate.

However, using the somewhat higher ingestion rate of 330 mg/day would not alter the conclusions of the risk assessment, except possibly at AOI 6. At AOI 6, the HI estimate (when written with one significant digit) would increase from 1 to 2 if maximum concentrations are used and HIs are not segregated. The higher HI is due primarily to the HQ for antimony increasing from approximately 0.4 to 0.8 based on the maximum concentration of 4,100 mg/kg at AOI 6 (at boring AOI 6 B-11 at the 7.5 to 8 ft depth interval). However, the higher HQ for antimony is still below the acceptable limit of 1, and the HI estimate (when written with one significant digit) would be 1 if the exposure concentration for antimony were based on the 95% UCL of 1,390 mg/kg.

3. Toxicity Values

As discussed in Section 5.05.C, the dermal toxicity values used in the risk assessment are oral toxicity values that were extrapolated to the dermal route without chemical-specific judgment regarding whether such extrapolation might be appropriate for a particular chemical. This is a conservative approach to ensure that potential risk via the dermal route is not overlooked. However, some constituents might exhibit different degrees of toxicity for the dermal route relative to the oral route. For such constituents, the extrapolation approach used in the risk evaluation could introduce uncertainty.

The conversion of an oral toxicity value to an inhalation toxicity value generally should be justified by consideration of a number of factors, including point of entry effects, pharmacokinetic data on the chemical's behavior in the different routes of exposure, and differences in the target

organs affected. However, as a conservative measure for constituents without any inhalation toxicity values, oral SFs and RfDs were converted to inhalation URFs and RfCs in this risk assessment. Use of these extrapolated inhalation toxicity values reduces the potential for underestimating inhalation risks, but could introduce uncertainty.

The toxicity values for chromium were conservatively based on those for the hexavalent form, even though most chromium in soil and groundwater at the Facility is expected to be in the much less toxic trivalent form. For example, the oral RfD for hexavalent chromium is 500 times more stringent than that for trivalent chromium. In the case of AOI 3, this conservative assumption resulted in a HQ of 0.6, which if added to the HQs for the other constituents would give an HI of 2. If the oral RfD for the trivalent form was used, the HQ for chromium would be approximately 0.001 and the HI even without segregation of effects (as discussed in Section 5.6.2.1) would be less than 1.

As noted on the tables in Appendix M (e.g., Attachment M.1), the estimates of cancer risk and HQ for TCE are calculated using toxicity values that are currently in effect, rather than the draft toxicity values that are currently under USEPA review and subject to significant ongoing scientific and regulatory debate regarding their appropriateness. This risk assessment did not use the draft TCE toxicity values because their current status makes them inappropriate for use to support RCRA corrective action decisions. However, using the draft toxicity values would not alter any of the risk assessment conclusions regarding whether estimates of cumulative cancer risk and HI exceed the USEPA-established limits of 10^{-4} and 1, respectively, for triggering the need for corrective measures under RCRA corrective action.

4. Risk Characterization

The summation of cancer risks and HQs for multiple constituents, as described in Section 5.06.A, is based on USEPA guidance (1989) to assume dose additivity, which means that constituents in a mixture are assumed to have no synergistic or antagonistic interactions and each constituent has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative cancer risk and HI estimates in this risk assessment are dominated by contributions from no more than a few constituents, so that the cumulative risk estimates are nearly the same as those for the few key constituents. An important exception is in the case of the HI estimate for exposure of routine workers to chromium and manganese in soil at AOI 3, which is discussed in Section 5.06.B.1.

As discussed in Section 5.06.B.1 and Appendix M, the significance of potential exposure of on-site routine workers to constituents in soil and groundwater via assumed vapor intrusion is evaluated based on occupational exposure limits. This approach is consistent with the Facility's obligations to comply with Occupational Safety and Health Administration (OSHA) regulations, and with its own programs for ensuring worker health and safety.

However, as a sensitivity analysis, the significance of these potential exposures was also evaluated using URFs and RfCs, rather than occupational exposure limits. The results of this sensitivity analysis do not alter the conclusions of the risk assessment, except possibly at AOI 6 and AOI 7 where upper-bound estimates of cumulative cancer risk and/or HI for vapor intrusion from soil exceed the USEPA-established limits of 10^{-4} and 1, respectively.

At AOI 6, upper-bound estimates of cumulative cancer risk and HI are 3×10^{-4} and 7, respectively. The cancer risk estimate is due primarily to the use of the maximum concentrations for benzene (110 mg/kg) and TCE (390 mg/kg). These concentrations are located at boring AOI 6 B-10 in the 9.5 ft to 10 ft depth interval and in the 10.5 ft to 11 ft depth interval. The HI estimate is due primarily to the use of the maximum concentrations for benzene (110 mg/kg), toluene (1,200 mg/kg), and xylenes (1,800 mg/kg), which are located at borings AOI 6 B-10 (in the 9.5 ft to 10 ft depth interval) and B-11 (in the 7.5 ft to 8 ft depth interval). At AOI 7, the upper-bound estimate of HI is 5, and is due primarily to the use of the maximum concentrations for toluene (2,900 mg/kg), xylenes (1,600 mg/kg), benzene (6.8 mg/kg), and naphthalene (840 mg/kg). These concentrations of toluene and xylenes are located at boring AOI 7 B-1 in the 6.5 ft to 7 ft depth interval, and the concentrations of benzene and naphthalene are located at borings AOI 7 B-3 and B-8, respectively, at the 3.5 ft to 4 ft depth interval.

These upper-bound estimates are highly conservative because they assume that vapor intrusion will actually occur and that the contaminated soil is located immediately beneath the building foundation. In reality, no building exists over borings AOI 6 B-10 and B-11 or borings AOI 7 B-1, B-3, and B-8, the concentrations used in the calculations are actually several feet further from the hypothetical building foundation used in the calculations, and the concentrations near the hypothetical building foundation are much lower.

Using more representative concentrations of toluene, xylenes, benzene, and naphthalene at AOI 7 (e.g., vertically-averaged) instead of the maximum

concentrations in borings AOI 7 B-1, B-3, and B-8 would reduce the HI estimate to 2 with no HQ higher than 1. Further refinement of the calculations (e.g., accounting for depletion of constituent concentrations near the building foundation, as suggested in Johnson & Ettinger 1991) would likely reduce the HI to less than 1. Similar refinement to the calculations for AOI 6 were not performed because GM is planning to remove the contaminated soil at borings AOI 6 B-10 and B-11 for other reasons, as discussed elsewhere in this report.

5.07 Summary and Conclusions

The significance of potential exposures to concentrations of constituents in soil, groundwater, sediment, surface water, LNAPL, and smear zone soil is evaluated based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use at and around the Facility. The evaluation uses the RFI data that were discussed in Section 4 and methods that are consistent with USEPA risk assessment guidance. The significance of potential exposures is determined by comparing estimates of site-related cumulative cancer and noncancer risks with a cancer risk limit of 10^{-4} and a HI limit of 1, respectively, which USEPA has established as triggers for corrective measures under RCRA corrective action (USEPA 1991b).

The Facility is currently active and is almost entirely paved. It is located in an area with a mix of both commercial/industrial and residential land uses. Receptors at the Facility and the downgradient areas include the following:

<u>Current</u>	On-Site:	Routine workers
	Off-Site:	Residents Routine workers Construction workers Recreational waders in Morses Creek
<u>Future</u>	On-Site:	Routine workers Construction workers Trespassers
	Off-Site:	Residents Routine workers Construction workers Recreational waders in Morses Creek

The potential exposures evaluated for these receptors are summarized in the conceptual site model shown on Table 5.1. Results of the evaluation are summarized below for each receptor population.

Routine Workers

The risk assessment evaluated potential exposures to outdoor soil at the Facility via incidental ingestion, dermal contact, and inhalation of vapors and particulates. Exposure via inhalation of soil and groundwater constituents assuming that they volatilize and migrate through cracks in building foundations was also evaluated. Risk estimates were calculated for the following areas:

- AOI 3 – Existing Drum Storage Area/Fill Area
- AOI 6 – Paint Mix Building
- AOI 7 – Former Bulk Fluids AST
- AOI 8 – Former Powerhouse Heating Oil ASTs
- AOI 10 – Former Storage Shed
- AOI 11 – Former Reclamation Area
- AOI 16 – Former Petroleum USTs
- AOI 17 – Company Car Fuel Point
- AOI 18 – Sewer Sediment
- AOI 20 – Bone Yard
- AOI 21 – Waste Thinner Handling Area/Powerhouse
- AOI 22 – Railroad Wells Within Building Interior
- AOI 23 – Former Interior Testing Pits
- AOI 25 – Former Drum Storage Area
- AOI 26 – Abandoned UST
- AOI 27 – Stained Asphalt Area
- AOI 28 – Southern Boundary Area
- AOI 29 – MW 18 Area
- General (soil samples collected during site-wide groundwater investigations)
- East Boundary Area

The conservative estimates of site-related cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1, respectively, at any of the areas. The mean lead concentrations in surface soil (0 to 2 ft bgs) do not exceed the range of soil lead criteria for routine workers, except at AOI 10 and AOI 11. Currently, AOI 10 and AOI 11 are paved, so that routine workers in these areas are not exposed to soil. The presence of lead at these AOIs could be related to the use of fill materials in developing the site, rather than due to a release from the Facility's operations.

Construction Workers

The risk assessment evaluated the significance of potential exposures to on-site soil during occasional construction/maintenance activities by using the risk estimates for routine workers, which is a conservative and streamlined approach. It was necessary to supplement this approach with risk calculations specific to the construction worker scenario at a few AOIs. These calculations show that constituent concentrations in on-site soil do not pose a significant risk to construction workers.

Potential exposures to smear zone soil and LNAPL during excavations at AOI 6 were evaluated in addition to other soil exposures. The risk assessment evaluated the significance of potential exposures to smear zone soil and LNAPL via incidental ingestion of smear zone soil, dermal contact with smear zone soil and LNAPL, and inhalation of LNAPL vapors. The estimates of cumulative cancer risk and HI for this scenario do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, for exposure to smear zone soil; but they do exceed the both limits for exposure to LNAPL. Currently, construction activities at the Facility are governed by health and safety protocols that would prevent any significant exposure during subsurface construction activities, including situations that would involve contact with the LNAPL.

The risk assessment also evaluated the significance of potential exposures to constituents in groundwater via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in groundwater do not pose a significant risk to construction workers.

Potential exposures of construction workers to sediment and storm water in the storm sewers were evaluated and determined to be insignificant. The cancer and noncancer risk estimates for this scenario do not exceed the limits of 10^{-4} or 1, respectively. The lead concentrations in sediment and storm water are also not significant.

Trespassers

The risk assessment evaluated the significance of potential exposures of trespassers to on-site soil by using the risk estimates for routine workers, which is a conservative and streamlined approach. Since the constituents in on-site soil do not pose a significant risk to routine workers, they do not pose a significant risk to trespassers.

Off-Site Residents

The risk assessment evaluated potential exposures to off-site groundwater downgradient of the Facility via vapor intrusion. The estimates of cumulative cancer risk and HI

based on the highest concentrations in the most downgradient on-site groundwater monitoring wells do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Recreational Waders in Morses Creek

The risk assessment evaluated potential exposure to sediment and surface water in Morses Creek via incidental ingestion and dermal contact. The estimates of cumulative cancer risk and HI based on the highest concentrations in sediment and stormwater from on-site storm sewers that discharge to Morses Creek do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1. Lead data for sediment and surface water samples collected from Morses Creek show that the lead concentrations in these media are not significant.

In conclusion, the risk assessment determined that current potential exposures to constituents in on-site soil and LNAPL, and on-site and off-site groundwater do not pose a significant risk. It also determined that future potential exposures to constituents in these media do not pose a significant risk, except at AOIs 6, 10, and 11. At AOI 6, concentrations of several VOCs in the LNAPL could pose a significant risk to construction workers via inhalation. At AOIs 10 and 11, concentration of lead in surface soil could pose a significant risk to routine workers via incidental ingestion. However, the Facility is almost entirely paved and subsurface construction activities are governed by health and safety protocols that would prevent significant exposures.

VI. SUMMARY AND CONCLUSIONS

Based on the results of the RFI/RI work to date, as summarized in this report, further investigation is currently planned. The proposed investigation includes soil investigation in several AOIs, as well as Facility-wide groundwater. Summary and conclusions will be provided after review and discussion of the results with the NJDEP and USEPA and upon completion of further investigation.

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